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CHILDREN'S RADIOGRAPHIC TECHNIC

SECOND EDITION

FORREST E. SHURTLEFF

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CHILDREN'S RADIOGRAPHIC TECHNIC

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PREFACE TO SECOND EDITION

THE second edition of this book was written for the students in radiography, as they embark on a two-year training period and as an aid to radiologists and *x*-ray technicians in the instruction of pediatric radiography to these students.

The demand for a unified training program for *x*-ray students has prompted the educational committee of the "American Society of *X*-ray Technicians" to compile and present the "Curriculum and Teacher's Syllabus." A considerable portion of this excellent book is devoted to pediatric radiography.

This material has been assembled with the sincere belief and hope that it will serve as a supplement to the outline included in the pediatric section of the "Curriculum and Teacher's Syllabus."

I wish to express appreciation, first of all, to the following gentlemen who rendered invaluable assistance in the preparation, editing and revision of this book. These include:—

Dr. Edward B. D. Neuhauser, Radiologist-in-Chief at The Children's Hospital Medical Center of Boston, and Clinical Professor of Radiology at Harvard Medical School in Boston, and Dr. Martin H. Wittenborg, Radiologist at The Children's Hospital Medical Center and Associate Clinical Professor at Harvard Medical School, who suggested several important changes in the revised material.

Dr. J. Leland Sosman, Chief Radiologist at the Robert B. Brigham Hospital, The Free Hospital for Women and the Joslin Clinic of Boston, and the Chairman of the two year training program for x-ray students at Northeastern University of Boston, who offered many excellent suggestions and carefully checked the completed manuscript before publication.

Mr. Charles Spalding, Radiological Engineer at the New England Deaconess Hospital. Mr. Spalding carefully assisted in the preparation of the material on "Protection from Radiation."

Dr. A. Bradley Soule, Professor of Radiology at the University of Vermont College of Medicine and Chief of Radiology at the Mary Fletcher Hospital in Burlington, Vermont. He is also chairman of the Committee on Technician Training of the Commission on Technician Affairs of The American College of Radiology. Dr. Soule has kindly consented to write a Foreword for this book.

My sincere thanks are due to all others who in many ways assisted in the completion of this manual.

FORREST E. SHURTLEFF

Boston, Massachusetts

FOREWORD

Several years ago while a group of radiologists and technicians were putting together the second edition of the "Curriculum and Teacher's Syllabus for Schools of X-ray Technology," one of the collaborators, who obviously had had little experience with children said, "Why do we have to devote a full chapter to pediatric x-ray procedures? After all, children are only young adults."

Those of us who have had to cope with the problem of trying to obtain technically perfect chest radiographs of a restless, fretful child or who have given a barium enema to a baby wracked with the pains of an intussusception or who have tried to enter a vein in a chubby arm or foot need not be reminded that children are as different from adults as polliwogs are from frogs or caterpillars from butterflies. Not only in the performance of x-ray examinations but also in interpretation of findings, an entirely different approach is required.

The conditions encountered in children are, with few exceptions, different from those found in older people. In addition to the hosts of congenital abnormalities affecting the cardiovascular system, the skeleton—in fact any part of the body—there is a wide variety of acquired conditions rarely seen in more mature individuals. Even fractures and respiratory infections frequently manifest themselves differently than in adolescents or adults.

This has brought about the development of a relatively new specialist—the pediatric radiologist, and his team-mate—the pediatric x-ray technician.

Forrest Shurtleff is one of those rare individuals in the latter category who combines technical knowledge and skills of high order with gentleness and a sensitivity to the needs of his small patients. Through years of experience in the superb teaching and research environment of Children's Medical Center in Boston, he developed methods of handling pediatric x-ray problems which he has been able to communicate to his students in training and, through his publications, to others.

In this book he has set down invaluable suggestions regarding the performance of all the widely used and most of the less commonly performed examinations involving infants and young children. With an economy of words, he has outlined, through simple instructions and with the aid of well chosen illustrations, the methods which have worked so well in his hands in producing informative diagnostic radiographs with a minimum of radiation to patients and attendants.

It is safe to predict that well-worn copies of this book will be found in the coming years in every radiology department in which x-ray examinations of young children are performed.

A. BRADLEY SOULE, M.D.

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1

EQUIPMENT AND ACCESSORIES

THE physical principles involved in the production of roentgenograms are the same whether the subject be an infant, child or adult. Description of the production of *x*-rays, photoreaction of the film and darkroom procedures will be left to more detailed works on these subjects.

The practical problem for the technician resolves itself into the selection of a technic that will produce roentgenograms with a minimum unsharpness (*i.e.*, maximum definition) at predetermined average densities and contrast.

Such technics can be worked out satisfactorily for children for any modern *x*-ray diagnostic apparatus with a capacity of 200 or more milliamperes in the 40 to 70 KV range. Specialized equipment is not essential. As a guide for preliminary orientation, the technical factors in Chapter 5 may be used. Modification of the factors in this table may be necessary for different machines. A correction factor, as adding or subtracting a certain number of kilovolts to the recommended figures, will then become necessary. As the *x*-ray intensity output of commercial equipment of the valve tube rectification type has varied relatively little in recent years, this correction factor should be small ranging at most to 10 kilovolts. Once determined for one type of examination, this same correction factor may be applied to other examinations in the table except that it may be necessary to increase it slightly more for the thicker parts of the body.

In the use of any machine, it may become necessary to increase the kilovoltage with age of the tube as the filament of the cathode becomes exhausted or the target of the anode becomes etched or flaked with use.

AVERAGE FILM DENSITY AND CONTRAST

The optimum average film density is a matter of the radiologist's preference. In general, film density should be such that the thickest or densest structure in the field of examination should be of a "lightness" which faintly reveals its structure and the thinnest portion in the field of examination should be of a "grayness" which faintly defines its structure. If these criteria are not satisfied, the variation in thickness and density of the structures is too great to be radiographed with one set of exposure factors and two examinations of the part must be made, one with a relatively higher voltage setting for the thicker parts and one with a relatively lower voltage setting for the thinner parts. An excellent example of this is radiography of the spine. Due to the differences in the bony thickness, the lumbosacral spine and thoracic spine cannot be well demonstrated by a single exposure. Separate radiography of each of these areas with the appropriate factors is the only method of achieving optimum density in both areas.

It is known that the range of densities on an *x*-ray film is increased for a given structure with higher voltage and decreased with lower voltage. With this increase in the range of densities, however, there is a proportionate loss of contrast. In children's roentgenology, it seems to be generally felt that the diagnostic value of visualizing the soft tissues is great enough to sacrifice some film contrast. Soft tissues, as well as bones, should be visualized in good roentgenograms of children with the exception of the skull, lateral spine and sacrum, where the soft tissues must be sacrified to gain good bone density. Therefore, it is generally agreed that the optimum KV setting is the highest that will still *not overpenetrate* the thinnest part but still penetrate the heavier parts of the structure under examination within the range of the timing equipment available.

Intensifying screens are considerably more sensitive to the variations in intensity of *x*-rays than to the variations in quality or wave length of the beam, and they present a "threshold phenomena" when activated by *x*-ray. These reasons make them less desirable for use in lower voltage radiography, and very little contrast is gained by dropping the voltage to 50 KV or below. If very high contrast is desired, low voltage without intensifying screens and preferably a non-screen film is recommended. This technic requires such long exposures that it can rarely be used in children's roentgenography.

DEFINITION

If all the factors influencing definition or "sharpness" in medical radiography are quantitatively evaluated, it is found both voluntary as well as involuntary (physiologic-respiration, heart, vascular, etc.) *motion* is by far the greatest limiting factor. In children this factor is still more difficult to combat than in adult roentgenography. The most effective single technical procedure available to reduce this factor is reducing the duration of the exposure of the film.

In roentgenography of children, one might generalize: if the intensity of the *x*-ray beam has to be increased, it is usually better to do so by raising the KV and holding the time to the minimum than by increasing the exposure time.

In the table of technical factors in Chapter 5 the "desirable" exposures are given. These are exposure times that have been found in practice to give satisfactory diagnostic roentgenograms for each type of examination in each particular age group. Should it be necessary to prolong these exposure times it will, of necessity, involve some loss of sharpness or definition.

Summary.—The major problem in children's roentgenography is to avoid the greatest single deterrent of good definition, namely motion. This can be best achieved by the shortest possible exposure for any given examination. This may be done by using the highest milliampere setting recommended for the tube by the tube rating chart of the manufacturer and by using the highest kilovoltage setting for a given part which still yields a contrast adequate of diagnostic interpretation. The desired average film density will then determine the total exposure. On this basis technical factors have been worked out empirically which have proven satisfactory, and which are presented in Chapter 4.

RADIOGRAPHIC ROOM ACCESSORIES

There are five simple devices which are helpful in holding children during radiography and can well be incorporated as accessories in any radiographic room:

1. A cotton webbing strap, 1 to 2 inches in width and 2 to 2½ feet long may be used to hold the head firmly in the true lateral and anterior-posterior positions as illustrated in figures 4, 7 and 10. Only ends

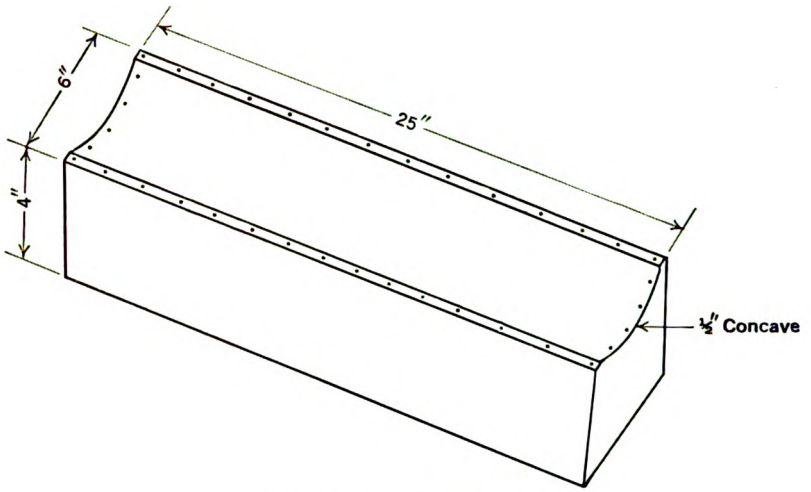

FIG. 1.—Acetabular box.

FIG. 2.—Open-end cassette holder.

FIG. 3.—P.A. chest position using open-end cassette holder.

of the strap need be held by the assistant, thus removing the gloved hands of the assistant from the field of the direct beam.

2. Non-stationary head holders are necessary for steadying the child's head in the posteroanterior view and sinus films. Any devices filled with soft rubber or radiolucent material which remove the gloved hands from the field of direct radiation may be used. Practical and simple devices, available in any hospital, are plastic inhalation masks used by the anesthetists. The air-inflated rubber rim of these co-adapts itself well to the skull for a firm hold and casts no *x*-ray shadow on ordinary skull films. The use of these is illustrated in figure 5.

3. Clean balsa wood boards of the type used in splints are readily available in most hospitals and are extremely practical for holding or steadying an extremity during radiography. Due to the soft, almost grainless, character of the wood they rarely cast a shadow on the film. Their use is illustrated in figure 27.

4. Sheets folded 3 to 4 inches in thickness may be used to elevate infants off the table for lateral hip radiography where it is important to direct the central ray horizontally through the level of the hip joint. A simple device may be built for this purpose which has proven very practical. It is a narrow rectangular box with curved top, upon which the patient is placed in the supine position. The dimensions and an illustration are given in Chapters 1 and 2, figures 1, 20 and 21.

5. Open-end chest cassette holder: Children are difficult subjects for upright chest roentgenography, not only because of the difficulty in making the exposure during full inspiration, but also because they rarely stand still and also resent having their faces pressed against a solid object or blank wall. These latter two difficulties can in great part be overcome by examining the patient in the seated position using an open-end cassette holder. The patient may be seated on the end of the radiographic table and his attention drawn to something in front of him. His arms may then be placed around the cassette with hands clasped (thus throwing the shoulders and scapulae forward). The simplest possible device which will hold the cassette in this position is desirable. The less equipment the child comes in contact with, the less apprehensive he will be.

An example of a device, simply made and found practical is illustrated in figures 2 and 3.

6. Some type of infant immobilization device.

X-ray departments which do considerable pediatric fluoroscopic work find an infant immobilization device of practical value. This device may be the regular compression band, or an inexpensive "Bratboard." A suggested board may be constructed of 3-ply-¼ inch plywood. Several coats of shellac are applied to prevent contrast media from seeping into the wood.

The child is secured to the board by the use of wide ace bandages. Baby and board thus become a single unit that can be moved into any desired position. Thus type of immobilization is advantageous during fluoroscopic examinations as it allows the radiologist and his assistant to proceed with the examination, with the assurance that the infant is safely supported.

7. To be considered as essential accessories in any radiographic room are radiation protection devices. Adequate mobile lead screens with lead glass windows may be used by those who must attend or observe the patient. A set of lead gloves and full-sized lead-rubber aprons should always be available for general hospital attendants called upon to steady the patient. The full-time radiographic technician should always confine himself to a radiation protected control booth during the actual exposure.

Fluoroscopic radiation protection aids should include shielding for the parts not under examination. These can be two large pieces of lead rubber or two pieces of sheet lead mounted on plywood and cut to the width of the fluoroscopic table. When placed between the table top and the infant, the area to be examined (chest-abdomen) can be left unshielded while the remainder of the baby is protected from direct radiation. This provides protection as well for the assistant holding the child.

8. Psychological aids in any pediatric department may include fluorescent pictures in the fluoroscopic room, children's furniture in the waiting room, toys and lollipops.

2

PROTECTION FROM RADIATION

THE use of radiation in medicine has proven of the greatest value in the early recognition, diagnosis and treatment of diseases of all kinds. This value is evident in the continued expansion of radiological departments and in the increase in personnel to take care of the more numerous demands for services.

The report of the National Academy of Sciences released in December, 1956, emphasized the possible dangers of excessive radiation in medical radiography and dentistry. This report pointed out that the inheritance system is particularly sensitive, and any radiation reaching the reproductive cells may result in mutations that could be passed on to succeeding generations. This report to the public created considerable discussion and some hysteria. Although most news reporters suggested sound consideration, others published statements that confused and frightened the general public.

The radiological profession had been aware of the serious effects of excessive radiation for many years. They had already been employing protective measures in their work with patients and stressing caution in their training of technicians in their departments.

The furor caused by the initial report in 1956 has had some adverse effects, but this report and subsequent reports, articles and scientific investigations have proven generally valuable to the *x*-ray profession. These articles have provided *x*-ray technologists an additional impetus to reconsider their practices in providing radiation protection for the patient. They have reminded *x*-ray personnel to show special consideration in shielding the gonads of all patients in the major potentially reproductive age group (up to forty years of age), especially infants and children and women during pregnancy.

CONCLUSIONS DERIVED FROM THESE REPORTS

The attending physician, the radiologist and the technician should all cooperate in this important program by:

1. Keeping the number of radiographic examinations to a minimum consistent with health and welfare.

2. Keeping repeat examinations because of technical poor quality to a minimum by careful technic.

3. The general use of high speed screens, fast films and maximum developing. This reduces MAS, and hence dose, to as low as 13 per cent when all are employed or 50 per cent when one is employed, using the standard base-line of par speed films, par speed screens and 3 minute developing at 68°. Film manufacturers have recently introduced an even faster film that results in a further reduction of MAS by ⅓ to about 10 per cent of the above standard. Preliminary investigation has shown that this super-speed film has resulted in films of good diagnostic quality without loss of film definition. The important contribution of any or all of these factors is a marked reduction in radiation to the patient.

4. Use of technics devised to reduce MAS even further. The general increase of 8 to 10 KV enables MAS to be reduced in children's radiography by an additional 50 per cent, without comparable increase in absorbed dose.

5. Faithful shielding of the pelvis during examinations where the abdomen and pelvis are not the subject of examination. Sheet lead or lead rubber strips should be placed over the gonads during abdominal and hip examinations, where this will not obscure necessary information.

6. The use of the smallest cone that will completely visualize the requested area. This not only provides shielding but, by reducing the volume radiated, decreases the dose to other organs by scatter.

7. Including in the tube housing a filter of 2 mm. instead of the previously recommended 1 mm. filter. KV factors must be increased 5 to 6 KV to compensate. This reduces radiation to surface and subcutaneous tissue. Manufacturers of diagnostic equipment are including in new installations a filter of at least 2 mm. in accordance with the recommendation of the National Committee on Radiation Protection, Handbook No. 76.*

8. Use of radiation protection devices specifically made for fluoro-

*Published by the National Bureau of Standards.

scopic examinations, especially with infants and children. These accessories may include lead rubber pieces or sheet lead pieces mounted on plywood, cut to the width of the fluoroscopic table for protection of the infant, and lead rubber gloves and lead rubber aprons for examining and assisting personnel.

9. The use of image intensification, where available. These machines are rapidly becoming widespread and have special desirability in pediatric radiology as the radiation dose to the patient is reduced by factors varying from 10 to 40. The limitation of field size becomes less important in dealing with children of younger ages with a comparable reduction in organ size. The application of *cinefluorography* permits the radiologist to observe the dynamics of motion with a reduction in radiation dosage to the patient by allowing repeated viewing of the same sequence without repeatedly exposing the patient.

RADIATION PROTECTION FOR THE OPERATOR

The *x*-ray technician has an added responsibility in his daily work; in addition to his consideration for each patient he has an obligation to his institution, his radiologist and himself to educate himself and observe safety factors provided for his protection. Recent scientific reports have called attention to the carelessness and laxity of *x*-ray technicians for their failure to adhere to accepted standards and regulations provided for their safety. Since countless articles have stressed radiation protection for the technician, any failure to conform to these regulations must be attributed to carelessness and apathy.

A review of several early reports and the National Committee on Radiation Protection Handbook No. 76 offers an interesting comparison regarding MPD (maximum permissible dose). It was generally agreed previously that a MPD for *x*-ray workers was acceptable at 0.3 roentgen per week, or a total of one roentgen unit for three weeks. The latest MPD figures in Handbook No. 76 have reduced this figure to 0.1 roentgen unit per week or 0.3 roentgen for a three week period. Although a several-fold safety factor has been allowed in arriving at this figure, it is still considerably greater than a careful technician will accumulate.

MEDICAL *X*-RAY PROTECTION UP TO 3,000,000 VOLTS

Reference is made to National Committee on Radiation Protection

Handbook No. 76, with which all radiation workers should be familiar. In general this recommends radiation safety instruction for all radiation workers and the designation of a qualified person as Radiation Protection Officer to supervise safety measures in any installation. These should include restriction of use of all *x*-ray equipment to properly trained personnel, the establishment of monitoring methods, the investigation of instances of excessive exposure and the prevention of their recurrence. Also, records should be kept of department surveys and of personnel monitoring.

Monitoring should be done on anyone working within an area where a radiation hazard may exist. There are various dosimeters and film badge methods, and commercially available monitoring services by mail at costs low enough, so that no department need forego them.

Monitoring devices should be worn on the chest or abdomen, as the limiting figure of 0.1 r/wk is for "total body irradiation," while the MPD for extremities is greater. For the same reason a device worn under a protective apron gives a closer approximation of the relationship to the MPD. Blood counts are of no value for monitoring purposes, but are only of value to determine pre-existing conditions and to establish base-line values for the individual.

Room shielding, protective barriers, protective doors, and "Fail-Safe" switches to prevent energizing the tube under unsafe conditions should be utilized wherever applicable. A technician should never deliberately circumvent any of these devices provided for his safety. Aprons, gloves, etc., should not be used instead of proper structural barriers and proper coning.

Extra vacation time should not be considered a substitute for adequate protection against radiation exposure.

SUMMARY

The use of radiation in medicine has steadily increased in magnitude over the years as its valuable contributions have expanded. Continuing investigation and experience have emphasized the possible serious effects of excessive radiation on the reproductive system. Reports have expressed concern for the general public and particularly infants and children, young adults and women during pregnancy. The attending physician, the radiologist and the technician can all cooperate in reducing radiation to a minimum by carefully planning each

radiographic procedure and providing protection for the patient, with particular reference to gonad shielding.

The *x*-ray technician has an added responsibility to his department and to himself to review and keep up with all the information available pertaining to protection from radiation and to conduct his work accordingly.

3

CHILDREN'S RADIOGRAPHIC POSITIONS

CHILDREN'S radiography presents additional problems associated with the patient, and the difficulty of eliciting even a minimum of cooperation. Occasionally a solution to these problems may be achieved by an unorthodox position or an unusual method of immobilizing the uncooperative patient.

The routine radiographic positions as applicable to adults and older children are completely described in any of the standard technic manuals. The uncooperative children, however, often need special films and unusual methods of obtaining them to accomplish standard requirements.

It is important that the technician have a definite plan for procedure with the young children. The advantages include the saving of time, films, and the energy of the operator, as well as minimizing the amount of radiation to the patient. A suggested sequence of procedure could be as follows:

a. Read requisition carefully.

b. Bring patient into the radiographic room. Speak to the child and make every effort to gain his confidence.

c. Explain procedure simply if the patient is old enough to understand. If not, brief any assistant or parent.

d. Assemble necessary equipment.

e. Set machine for first exposure.

f. Position patient.

g. Shield gonadal area, if possible.

h. Make exposure.

FIG. 4.—Lateral skull, supine position.

FIG. 5.—P.A. skull, position maintained by use of anesthesia cones.

SKULL

The standard positions necessitate at least:

1. An anteroposterior view.
2. One lateral stereoscopic view or one lateral of each side, depending on the disposition of the patient and his age.
3. One posteroanterior view.
4. A basal or cerebellar view.

These four are the minimum number of views necessary in the study of the cranial vault. Additional films are often valuable when the originals have shown evidence of positive findings.

The anteroposterior (A.P.) position is best taken with an assistant holding the patient's chin firmly. The central beam is directed through the external canthus of the eye and the external auditory meatus. The occipital view is taken in the same fashion, except that the patient's head is held down, and the tube tilted 15° caudad, so as to allow the central ray to pass directly through the occipital bone; this is accomplished usually by directing the central beam through the frontal hairline and external auditory meatus.

Lateral views in children may often be taken best in the unorthodox supine position. An assistant holds a webbing strap tautly across the frontal and parietal areas, with the patient's head turned to the lateral position. Uncooperative children may thus be readily immobilized, and no support under the chin is necessary since pressure on the webbing strap controls the rotation. The C. R. is directed through the sella turcica ½ inch anterior and ½ inch cephalad to the external auditory canal. Children have a pronounced flexibility of the neck and with few exceptions are completely comfortable in this position.

Little children often get frightened when they cannot see what is being done, so the posteroanterior view is suggested as the last in the skull series. A small sandbag is placed under the chest at the level of the sternum. The arms are held firmly at the sides. The assistant may either hold the patient's head down with the webbing strap or steady the head with a pair of celluloid anesthesia masks. The latter method has proven more satisfactory. Movement is controlled and visibility increased. The patient's head is placed with the forehead and nose in contact with the table top or the cassette. The C. R. is directed at the midoccipital area (Fig. 5).

Two special views of the skull may be mentioned.

1. The tangential view, when a fracture or fractures have been seen on the original films. These are taken with the involved areas held in a direct plane so that the central ray may pass directly through the involved area without superimposition of any obstructing shadows. Reduced kilovoltage is suggested as the thickness is reduced.

2. The "Hirtz" or sub-mental position is used to demonstrate the base of the skull including the anterior half which is not seen in the ordinary basal view. The patient is placed on the table with several

sheets folded under his back and shoulders. His head is then arched back until the tip of the mandibular ramus and the auditory canal are on the perpendicular line. The tube is tilted approximately 5° cephalad and kilovoltage factors increased slightly over that of the standard occipital position. The patient is often uncomfortable in this position and should be radiographed immediately. The C. R. bisects a line between the outer canthus of the eye and the external auditory meatus.

SINUSES—MAXILLAE; MALAR BONES

Standard Position

1. Nose-chin, antra, or "Waters" position.
2. Nose-brow, or frontal position.
3. A lateral nasopharynx to demonstrate amount of adenoid tissue present.

The "Waters" and frontal positions are taken with the patient prone. The cassette is tilted 15° and the central ray is directed straight through the head. A cone 3 inches in diameter should be used with the cone 2 inches from the top of the head. This 2-inch distance is contrary to advised adult practice, but is necessary with apprehensive little children.

The lateral view for demonstration of the nasopharynx is taken with the patient supine and with the arms at the sides. The tube is tilted in horizonal position and the central ray directed through the face to the cassette, which is placed in a perpendicular position. Cooperative children are requested to inhale and then exhale, and the film is taken at passive expiration. This procedure reduces the amount of blurring due to motion. This view is of particular usefulness in demonstrating excess adenoid tissue, being much simpler than attempting direct inspection of the throat.

Upright sinus radiographs are practical only on cooperative children. Infants and little children who really need these upright films should be thoroughly sedated. The patient is held upright in postero-anterior position, with the chin in contact with the film. The nose is held approximately 1 inch from the cassette, and therefore not in contact. The central ray is directed in a true horizontal plane directly through the head to the perpendicularly placed film.

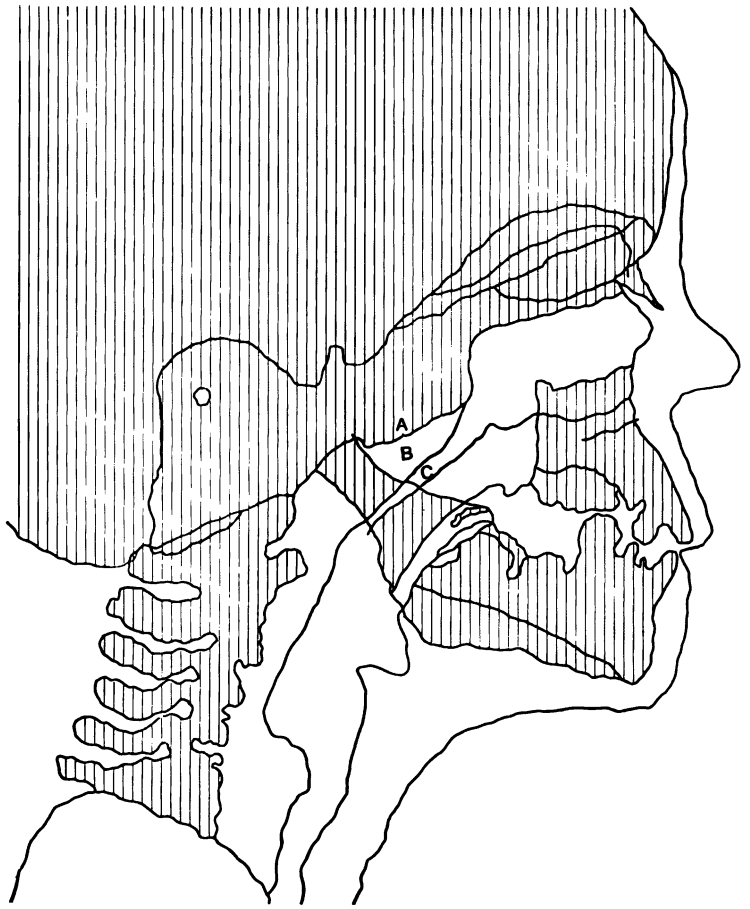

FIG. 6.—Lateral nasopharynx. Result. *A*, Anterior cranium. *B*, Adenoid tissue. *C*, Nasopharynx.

MASTOIDS

Suggested Positions:

1. Basal view of skull.
2. Lateral views of both mastoid areas.

The basal or occipital skull position is recommended for a true anteroposterior view of both mastoid cell groups. Lateral views are taken with the patient pronated, and with the arms held at the elbows by one assistant. The pinna of the desired ear is folded forward and a webbing strap held across the frontal and parietal areas. Lateral mastoid films are best obtained with the cassette tilted 15° caudad and the central ray directed at the centered mastoid. This tilting of the cassette re-

FIG. 7.—Lateral mastoid using cassette holder.

moves the upper ear from the focal area and prevents superimposition. A 3-inch cone with a 2- or 3-inch distance above the patient's head is recommended.

CHEEKS

Soft tissue radiographs of the cheek are frequently requested to discover the possible presence of foreign bodies or radio-opaque stones in the parotid duct. Tangential views are recommended, taken with the child's cheek inflated with air. An assistant holds the patient's head (on either side) with a very slight rotation of the head and face so that the desired cheek is not superimposed over the mandible. A 3-inch cone is suggested with the distance 4 to 6 inches from end of cone to film, and the central ray directed at the inflated cheek.

NASAL BONES

Suggested Positions:

1. "Waters," or nose-chin sinus view.
2. Laterals of either side, using cardboard exposure holders.

The standard "Waters" position, with a slight increase in kilo-

voltage, is recommended for a true posteroanterior view. For the lateral views cardboard exposure holders offer excellent detail of both the bones and the soft tissues. A suggested exposure is one that might be used for a hand or a wrist. Films of uncooperative children should be taken with the prone position and with the child's shoulders held evenly by one assistant, while another assistant holds the head. The superior-inferior or axial view, with occlusal dental films, has not proven valuable in children's studies because the bony bridge is insufficiently developed.

ORBITS AND OPTIC FORAMINA

FIG. 8.—Position for optic foramina.

The standard frontal sinus position is suggested for comparison of both orbits.

Optic foramina are most easily taken with the cassette flat and with the patient prone and placed so that the malar bone, the top of the orbit, and the side of the nose are in uniform contact with the film. The central ray is directed at the centered eye. This view is most important in demonstrating the optic foramina and the orbital walls.

MANDIBLES AND TEMPORO-MANDIBULAR JOINTS

1. The posteroanterior view is recommended for a comparison of each half of the mandible. The patient is placed in the same position as for a frontal skull exposure, with the tube directed at the mandibular areas.

2. Oblique views of both sides should be included. This position is facilitated by placing the patient prone upon a medium-sized pillow, with the pillow under the chest and shoulders. The cassette is tilted

FIG. 9.—Oblique lateral of mandible.

10° cephalad. The arms are pulled down and held firmly at the sides. The tube is tilted 10° posteriorly and the central ray is directed at the ramus of the positioned mandible. This tilting of both the patient and the tube eliminates superimposition and gives a clear unobstructed view of the desired structures as far posteriorly as the temporo-mandibular joint.

The temporo-mandibular joint should be taken separately, if a film of it is needed. The regular lateral mastoid positions are advised, with the central ray directed at the joint space. If cooperation permits, comparative views are suggested:

1. With the mouth closed.
2. With the mouth wide open.

An additional position is suggested for examination of the symphysis. The patient is placed supine with the head held as far back as possible. An occlusal dental film is placed or held in the mouth and the mouth is closed. This film is perpendicular in position. The central ray is then directed horizontally at this area.

ZYGOMA

1. The standard "Waters" position is recommended for visualization of the zygomatic arches with a 15° tilt of the tube caudad.
2. The submental or "Hirtz" view may be of additional help in the elimination of superimposing structures.

3. The ordinary basal view, with the central ray directed at the face instead of the occipital bone.

4. A direct lateral of the face may be included, but is rarely of value because of overlying structures.

NECK AND CERVICAL SPINE

Radiographs of the neck and cervical spine are taken in the same area, but they should be treated separately, since soft tissues require a softer film than those in which the vertebrae are involved, and reduced kilovoltage factors should be employed.

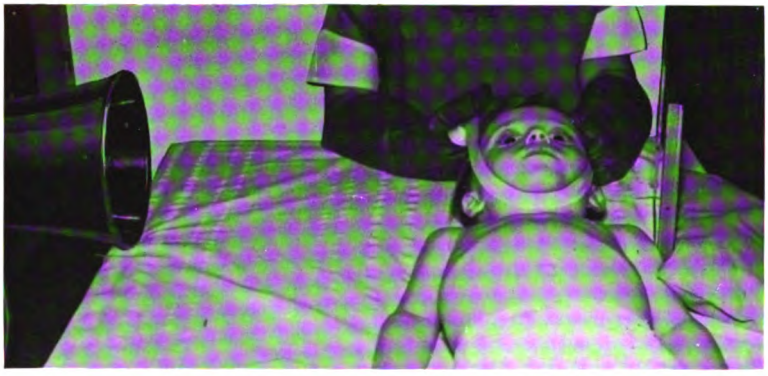

FIG. 10.—Lateral view of cervical spine.

The standard anteroposterior and lateral positions are recommended. The anteroposterior position is taken with the chin erect and with a 10° cephalad tilt of the tube so that the chin will not be projected over the spine. The lateral position, with older children, should be taken at a 72-inch distance to prevent distortion of the image.

A webbing strap is helpful with uncooperative patients. An assistant holds the strap tautly across the point of the patient's chin, and holds it firmly on either side of the head. This keeps the chin up and prevents rotation of the head to either side. Another assistant, or a parent, holds the arms at the sides. The lateral position is maintained the same way. The patient is elevated on several folded sheets. The tube is tilted in a horizontal position and the cassette is held in the perpendicular position.

Patients with torticollis, fracture, or subluxation in which the first

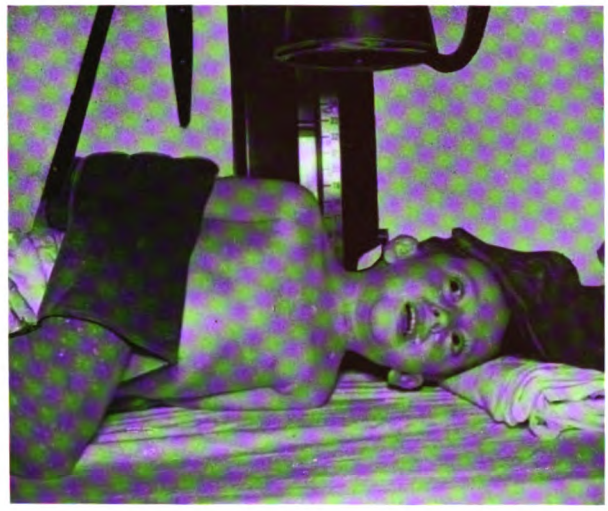

FIG. 11.—Lateral cervical spine using Bucky diaphragm.

and second cervical vertebrae are involved should have a spot film of this area. The Bucky diaphragm should be used whenever cooperation permits. A cone of 3-inch diameter or less should be employed, distance 20 inches from cone to cassette, with the central ray projected ½ inch caudad to the upper teeth. The head should be held in neutral position and the mouth kept opened as far as possible. Little children present a problem since they usually refuse to open their mouths. If the cone, position and controls are prepared, an opportunity will be presented when the patient cries or breathes deeply.

A lateral view, using the Bucky diaphragm, is valuable whenever bone definition is essential. The patient is held on his side in a direct lateral position, and the central ray is directed at the centered area.

The kilovoltage should be the same as that required for the standard anteroposterior view.

Right and left posteroanterior oblique views are often desirable. The patient should be taken upright, and rotated 20° to the desired side. Distance should be 72 inches, if possible, and the exposure factors used are comparable to those of the standard lateral view.

Right and left anteroposterior oblique views, using the Bucky diaphragm, are of additional value. The patient is placed supine and his head is rotated into a true lateral position. A spot cone is desirable. Exposure factors are comparable to the standard anteroposterior view.

THORACIC AND LUMBAR SPINE

The standard anteroposterior and lateral views are recommended. The Bucky diaphragm should be employed whenever cooperation permits, or a stationary grid may be substituted with little children. It is advisable to radiograph the spine in sections, as the lumbar spine and sacrum necessarily need more penetration than the thoracic area. Small or medium-sized films carefully focused afford satisfactory visualization of the intervertebral spaces.

Little children should be supported by an assistant and a parent. The arms are held firmly above and on either side of the head, and the pelvis is held on either side. This method of holding maintains contact and prevents rotation.

SPECIAL PROBLEMS

A. Infants with meningoceles or tumors need two additional views.

1. A spot anteroposterior view with kilovoltage increased to allow proper visualization of the vertebrae beneath the tumor.
2. A spot lateral view of the tumor itself with reduced kilovoltage to clarify the relation of the soft tissue mass to the vertical parts or to vertebral anomalies.

B. Patients with tuberculosis of the spine, with a kyphos present, need a spot lateral to visualize the actual amount of vertebral wedging or destruction.

C. Several special views may be necessary in the pre- and postoperative studies of scoliosis of the spine. The use of a (14 × 17 inch) cassette is suggested.

1. An anteroposterior recumbent view of the thoracolumbar spine.
2. A lateral recumbent view.
3. An anteroposterior standing view.
4. Right and left lateral bend views.
5. An upright sitting view with patients who cannot stand.
6. An upright sitting view with a lift under one buttock.
7. A postoperative view of the spinal graft in the off-lateral position. The patient is rotated anteriorly 20° from the true lateral position with the C. R. directed at the operative area.

FIG. 12.—Lateral bending position of spine with "scoliosis" patient.

From the anteroposterior and lateral views is derived the needed information concerning the bony architecture of the spine, the direction of curves, and the presence or absence of anomalies which may affect or cause the curve.

Right and left lateral bending films also aid in distinguishing postural from structural curves. In the former, the curves allow equal bending upon attempted opening of the curve.

Pelvic tilt films are taken with a large sandbag or a pile of sheets under one buttock. This lift should be about 3 or 4 inches in height, or enough to cause the patient to make considerable effort to maintain balance.

These varied views are taken alike in many respects. Large (14 × 17 inch) films are used. The tops of the iliac crests are included, but if either is missed due to pelvic tilt, etc., the films must be repeated. This type of film gives a clear and comprehensive picture of the curve in its entirety, and any deviation can be accurately measured.

In order to demonstrate the neural arches and pedicles of the spine, 45° anteroposterior obliques may be necessary. This is important in spondylolisthesis, fractures, etc. The patient should be rotated 45° from the A.P. position, with the central ray directed through the more anterior side.

In severe lordosis, or anterior curvature of the lumbar spine, an ad-

ditional A.P. spot film is necessary to demonstrate the lumbosacral junction. To take this view, it is recommended that the patient be placed in the supine position, and the tube be tilted 15° to 45° cephalad depending on the extent of the deformity. MAS factors should be increased from those of the standard anteroposterior position. A 3-inch cone should be used, with the central ray directed at the lumbosacral joint.

SHOULDERS

1. The anteroposterior view of both the shoulders with arms supinated is suggested so that each is available for comparison. Both elbows should be steadied close to the body and held in a true comparative position and the head should be maintained in an anteroposterior position.

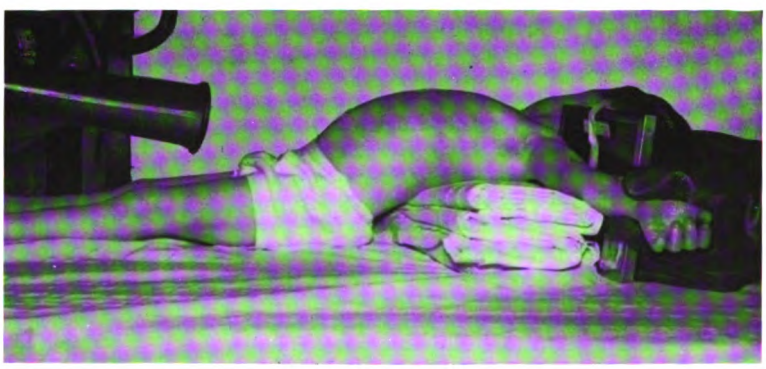

FIG. 13.—Lateral shoulder position with C.R. projected through axilla.

2. A true lateral of the entire humerus may be obtained with the patient supine. The arm is abducted and the elbow flexed to a 90° angle with the forearm supinated so that the thumb is in contact with the table above the shoulder. (Hitchhiker's position.) This view is necessary for complete study of the humerus.

3. Stereoscopic anteroposterior films are recommended with cases of dislocation, if cooperation permits.

A. The posteroanterior oblique of the clavicle is a necessary addition when patients have clinical evidence of fracture through the middle third. The standard anteroposterior position often fails to show

this area because of the normal curve of the clavicle. The patient is turned prone and rotated 45° and the affected clavicle is placed in contact with the cassette. This is a posteroanterior oblique position. The patient should be steadied at the hip, shoulders and head for maintenance of this special position. A 3-inch cone is advised.

B. Patients with a possible injury of either shoulder need a true lateral view with the central ray projected through the axilla. The affected shoulder is elevated upon sheets, the tube is tilted in the horizontal position and 10° towards the body or medially. The arm is fully extended and held by an assistant in a true supine position. The central ray is directed through the axilla toward the cassette which is held in a perpendicular position against the shoulder. A 3-inch cone is advised for elimination of secondary radiation (Fig. 13).

C. Examination of the scapula warrants a lateral view in addition to that of the standard anteroposterior position. The patient is placed in an oblique posteroanterior position with the arm held at the side posteriorly. The patient should be rotated approximately 45° and the central ray directed at the scapula on end.

CHEST

It is impossible to obtain satisfactory stereoscopic posteroanterior films with most children. Little children do not retain their breath for a fixed time, and many of the older children are nervous and exhale too rapidly. Therefore, an upright posteroanterior film at 72 inches and a lateral at 36 inches are generally used.

Chest films offer perhaps the most graphic example of the value of the unorthodox position. The upright position is of no value if the back is arched or the patient pulls away from the cassette. As a necessary substitute the patient is reversed to an anteroposterior posi-

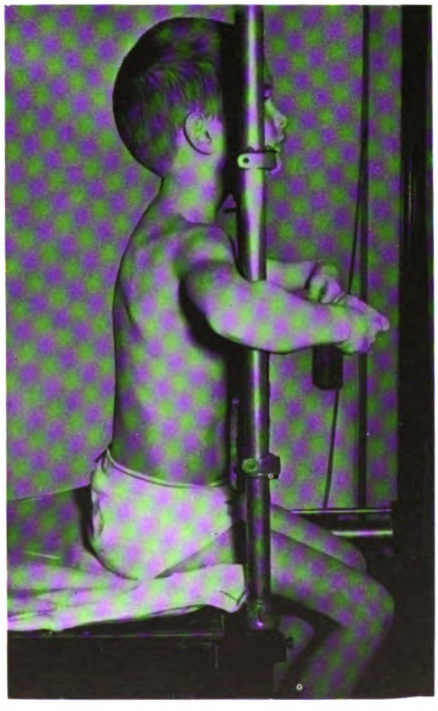

FIG. 14.—P.A. chest with open-end cassette holder.

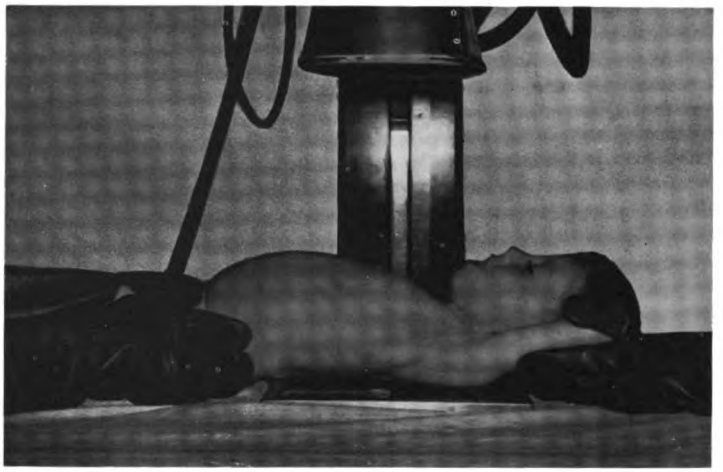

FIG. 15.—A.P. chest, supine position.

tion with arms uplifted and supported at the elbows by one assistant, while another assistant braces the pelvis. The alternative is to take the picture at 40-inch distance with patient in the supine position with the elbows, head and pelvis held firmly. The result justifies the unorthodox position.

Little children who need heart films and cannot be held erect, must necessarily be taken recumbent at a target-film distance of 72 inches. These films are valuable in determining the true size of the heart, as, at this distance, magnification is eliminated. The patient is placed in the posteroanterior position on a blanket, on the floor. One assistant brings the child's arms above the head on either side. This type of grip prevents rotation of either the body or the head. A parent or another assistant holds the child's pelvis and knees down. Assistants need lead aprons and lead gloves at this distance as there is considerable scattered radiation.

Tuberculosis in childhood frequently shows enlargement of the hilar lymph nodes and an additional left posteroanterior oblique film is recommended. This position brings out the tracheal bifurcation clearly and often reveals hilar nodes which cannot be seen in the standard positions. The central beam is directed between the distal ends of the scapulae to the centered film.

An additional anteroposterior view using the Bucky diaphragm is

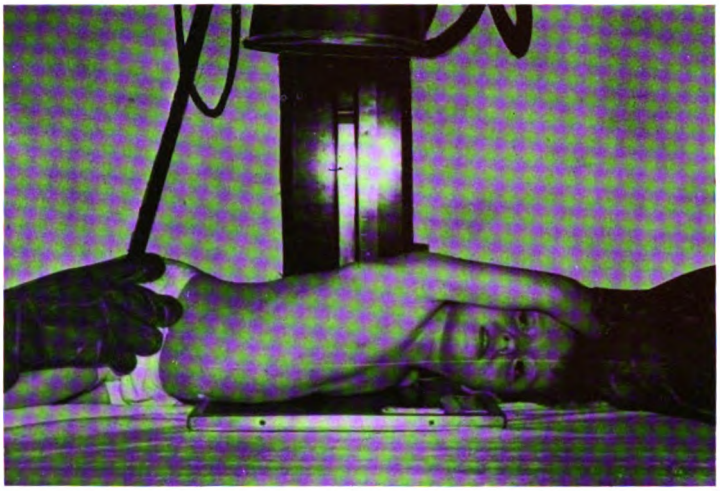

FIG. 16.—Chest, left anterior oblique position.

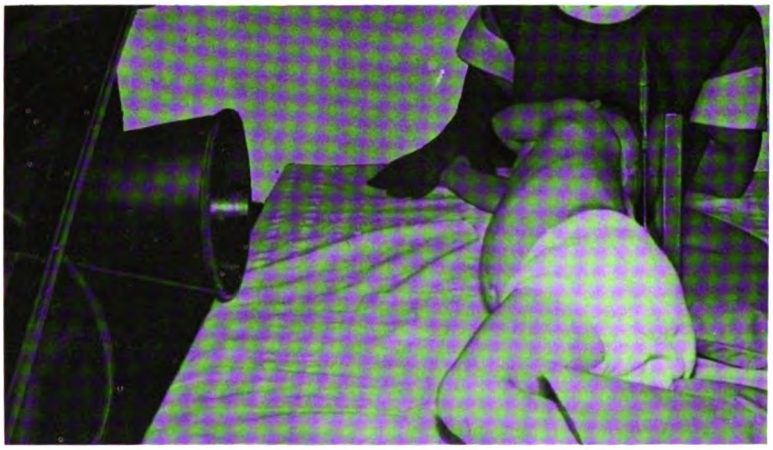

FIG. 17.—A.P. chest with the patient lying in the lateral position.

advised with patients who have lung or pleural areas where extreme densities or fluid is present, and the original ordinary exposures are not diagnostic. This view shows the bony thorax well.

The anteroposterior or posteroanterior view with the patient lying in true lateral position is valuable in the determination of horizontal fluid levels. The patient should be placed with the affected lung up. The arms are brought up and held on either side of the head. The central ray is projected horizontally through the area to the cassette,

which is held in a perpendicular position. A suitable contrast medium may be used in this position on empyema cases to show the size and position of known cavities.

ABDOMEN

The standard anteroposterior position is recommended in all infants and children. A film large enough to include the diaphragms

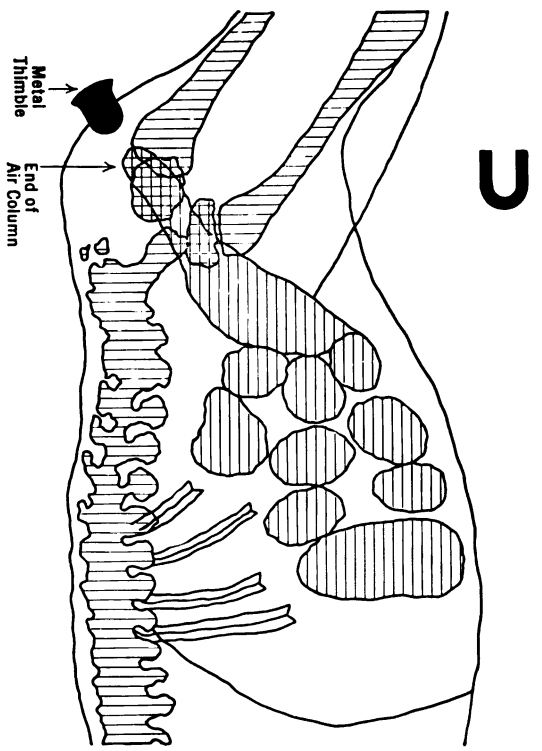

FIG. 18.—Inverted abdomen, lateral upright position (result).

and the symphysis pubis should be used with a Bucky diaphragm if cooperation permits. An upright film should be included when conditions such as obstruction, sub-diaphragmatic abscesses, or diaphragmatic hernia indicate the need.

Little children are often too restless to permit the longer exposure possible with an older child and for this group the stationary grid is substituted. Uncooperative patients are steadied by one assistant holding their arms on either side of the head and another holding the patient

just below the pelvis. Little children who cannot stand are suspended and held against the cassette in the same manner. Films should be taken at expiration when the patient is most relaxed. The central ray should be directed at the umbilicus. Lateral views may be added at the discretion of the radiologist.

Many newborn infants are admitted with imperforate anus. Immediate pre-operative films are needed to determine the distal or lowest end of the patent colon as a guide for operative intervention. The following procedure is advised:

1. A standard anteroposterior view is taken supine.
2. The patient is inverted for several minutes to allow the colonic gas to reach its maximum distal penetration.
3. A metal thimble is held against the anal dimple, and anteroposterior and lateral views are successively taken in the upright inverted position.

HIPS

The standard stereoscopic Bucky anteroposterior view is advised with the patient's knees held parallel by an assistant in a true comparative position. Patients who show positive findings should have a lateral oblique (frog-leg) view included. The femora are equally abducted and externally rotated, as far as any deformity will allow. This provides a true comparison of an affected hip with the other. Direct radiation to the gonads may be reduced by shielding with lead.

Lateral views can be taken separately with the femur completely abducted and the patient rotated approximately 30° toward the affected hip. A medium-sized sandbag is placed under the opposite buttock as a means of support and of maintaining stability. Hips taken on smaller children are positioned in the same way, but a stationary grid is substituted for the Bucky diaphragm.

Congenital dislocation of the hip is a fairly common condition amongst newborn infants. The standard stereoscopic position is helpful, but unfortunately the usual lateral in abduction does not show milder degrees of anterior or posterior displacement. A position to show a true lateral view was developed for this use, and is referred to as the lateral acetabular position.

The patient is placed upon a special box, trough or a pile of sheets. The legs are fully abducted and the cassette is placed in a perpendic-

ular position against the perineum. The tube, with a 3-inch cone attached, is tilted in a horizontal position and slightly medially. The patient must be angled slightly so that the central ray just passes by the iliac crest and the anterior spine of the ilium. The target film distance is 40 inches. The acetabular view is valuable for several reasons:

1. It shows the relationship of the femoral head to the acetabular notch:

(*a*) whether the femoral head is anterior or posterior; and (*b*) it gives an impression of the articular space.

In acetabular laterals, gonad shielding is not feasible and, therefore, this view is reserved for special indications.

A.P. VIEW OF HIPS—PUSH-PULL TECHNIC

The A.P. view of both hips with push-pull technic is occasionally requested with acetabular deformities or unstable hip conditions. The patient is firmly supported by a compression band placed across the abdomen just above the iliac crests. The machine is turned on and the rotor started. The attending physician grasps the patient's thighs with gloved hands and pulls down on one leg while pushing up on the other. At the physician's signal the film is taken. The push-pull technic is reversed for the second film. The gonads should be shielded.

EXTREMITIES

Every extremity examination should include one joint with emphasis upon the importance of the true anteroposterior and lateral positions. Occasionally, this is impossible, especially with new fracture cases. Two views, taken at right angles, are therefore necessary. The standard anteroposterior and lateral positions are suggested in studies of fractures, osteomyelitis, bone tumors, bone cysts, and any localized anomaly. Uncooperative patients must be taken supine with an assistant holding firmly above and below the desired area. This maintains true position and rotation is prevented.

The unorthodox technic offers a solution to many difficult extremity positions:

1. Knees and lower extremities are easier to radiograph in the

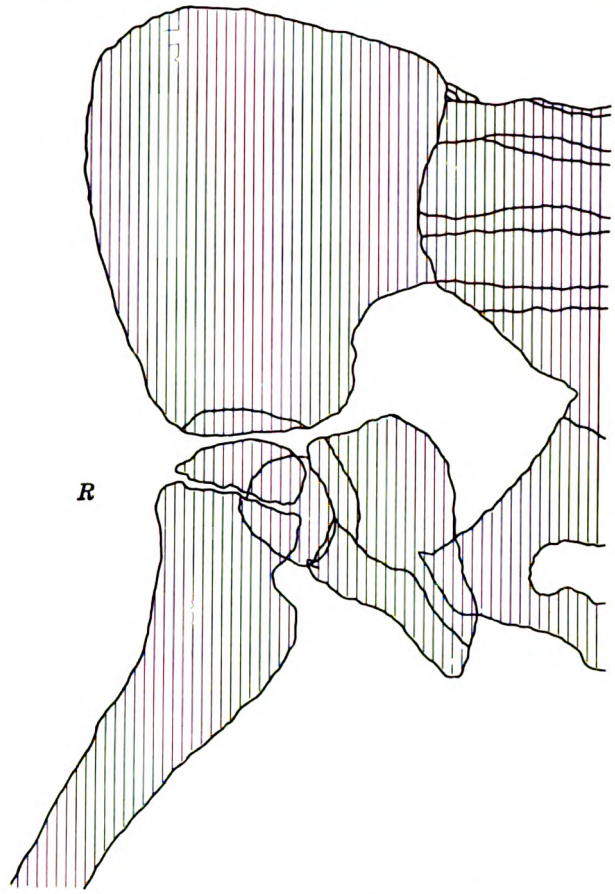

FIG. 19.—Lateral hip with femur abducted and externally rotated (result).

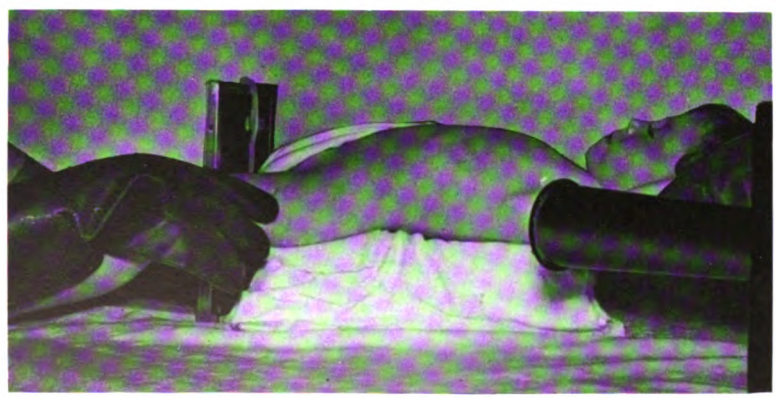

FIG. 20.—Lateral acetabular position; patient elevated upon acetabular box.

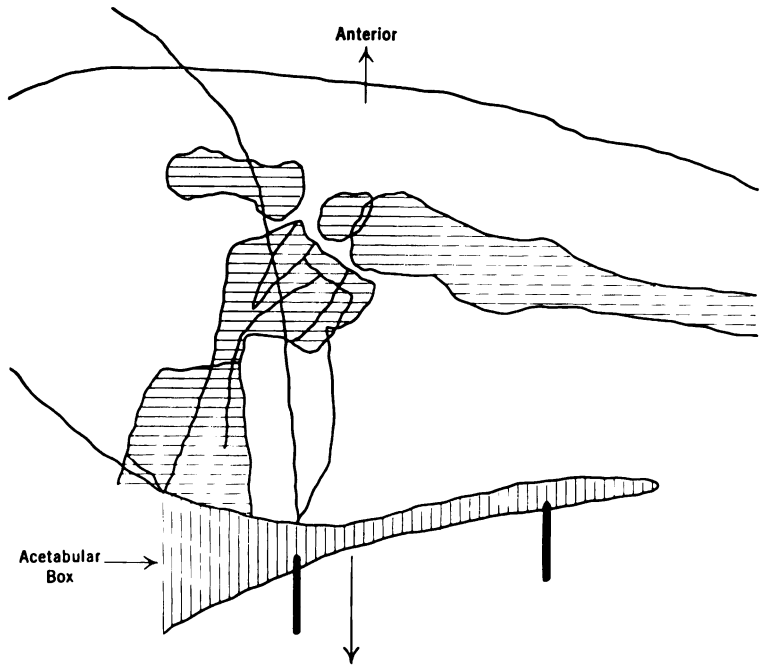

FIG. 21.—Lateral acetabular, or lateral hip (result).

posteroanterior position because the knees cannot be flexed and the contact remains uniform. The assistant holds either foot of the patient and a parent may be asked to hold down the hips, or a compression band may be employed.

2. The hands of uncooperative patients are more easily held in the posteroanterior position. A piece of splint board, balsa wood or a lucite paddle is placed on the back of the hand and held on either side. This thin board is radiolucent and allows uniform contact of all bones with the exposure holder or cassette.

3. The tangential anteroposterior knee view is taken to visualize the posterior or undersurface of the patella. The patient is placed supine with the knees flexed. The tube is tilted into a horizontal position and the central ray is projected at the patella, which the flexed position has brought into a tangential position. The cassette is held at right angles to the central ray.

4. A direct lateral view of the wrist, forearm, elbow and humerus, with infants and uncooperative children, is taken in the supine position with the patient's arm abducted and externally rotated and with the lateral surface in contact with the cassette. This view is advised

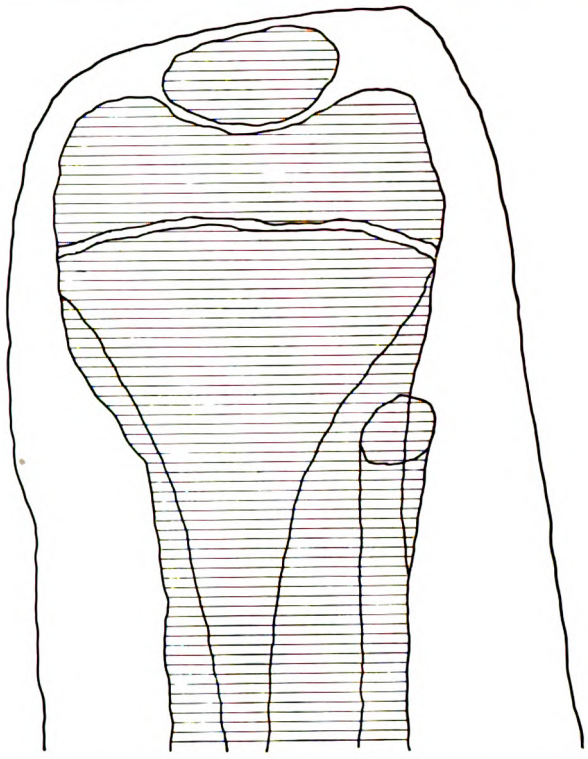

FIG. 22.—Tangential A.P. projection of knee (result).

FIG. 23.—P.A. view of knee, kneeling position.

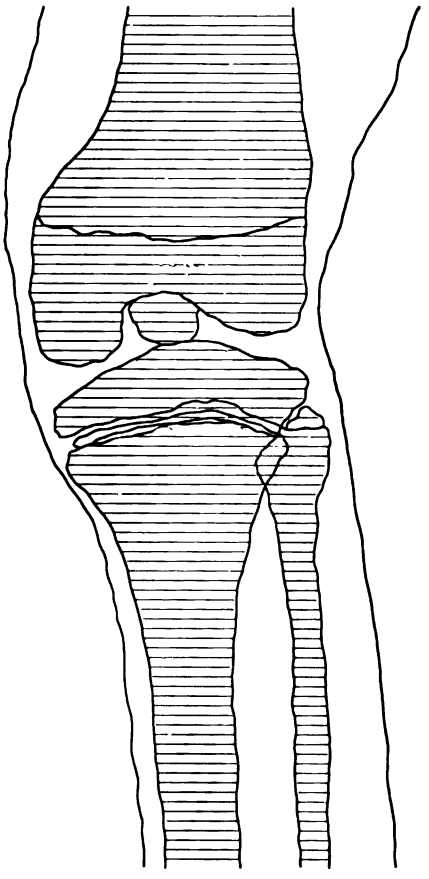

FIG. 24.—P.A. view of knee, kneeling (result).

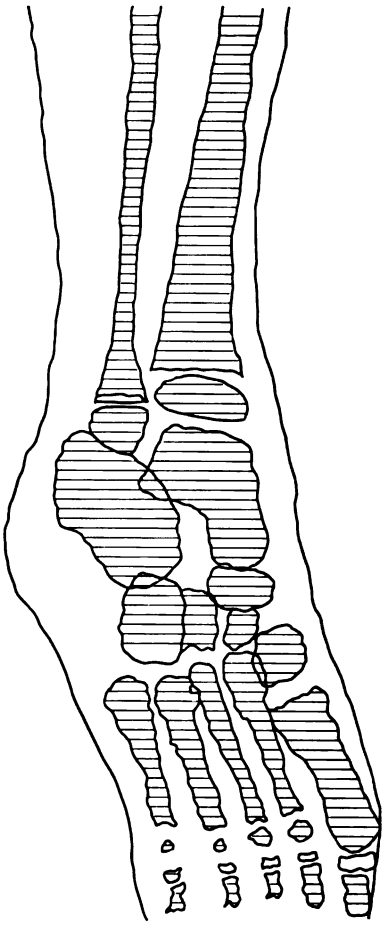

FIG. 25.—Lateral-oblique ankle position (result).

routinely for examinations of the upper half of the humerus in addition to the standard anteroposterior view. (See page 30.)

There are several special views of importance that aid in interpretation and treatment, when the standard films have shown positive findings.

A. The kneeling posteroanterior or intercondylar tunnel view of the distal femur. The patient is placed on hands and knees with the cassette directly under the knees. The knees should be flexed about 20° from extreme extension and the tube tilted 15° cephalad so that the central ray is directed through the knee joints. The standard anteroposterior tunnel view may be substituted with patients who cannot kneel due to injury or anomaly.

B. The lateral oblique ankle position is recommended for sprains

and questionable fractures of the external malleolus. The usual standard lateral view superimposes the astragalus over the external malleolus and, consequently, incomplete fractures may be obscured. The patient is pronated with the ankle turned in posteroanterior oblique position. The tube is tilted 5° caudad with the central ray directed at the fibular epiphysis. Regular ankle technic is adequate.

C. Oblique views of the wrist are helpful in the visualization of the carpal bones.

D. Transcondylar and supracondylar elbow fractures are often placed in acute flexion when reduced. They are usually kept this way until satisfactory callus formation develops. It is important to re-examine these elbows frequently, and so the anteroposterior view in acute flexion becomes necessary. The elbow is placed on the cassette in true anteroposterior position with the condyles parallel to the film. The tube is tilted 10° cephalad and the central ray is directed at the flexed elbow (Fig. 26).

E. Details of bone tumors, bone cysts, or other lesions of the femur or humerus are often better demonstrated by the use of a spot cone and the Bucky diaphragm.

F. Many polio cases develop shortening of an extremity as the acute state of the disease ends. It is important that the obvious shortening be measured accurately so that supports or appliances may be constructed to insure adequate posture. Teleroentgenograms or *x*-rays for measurement are used for this purpose. With small children these films are taken at a distance of 72 inches with the patient supine on a blanket placed on the floor. Both extremities must be carefully lined up in a true anteroposterior position. The lower legs should be taken on a single film and the femora on another. Films should be long enough to include the joints

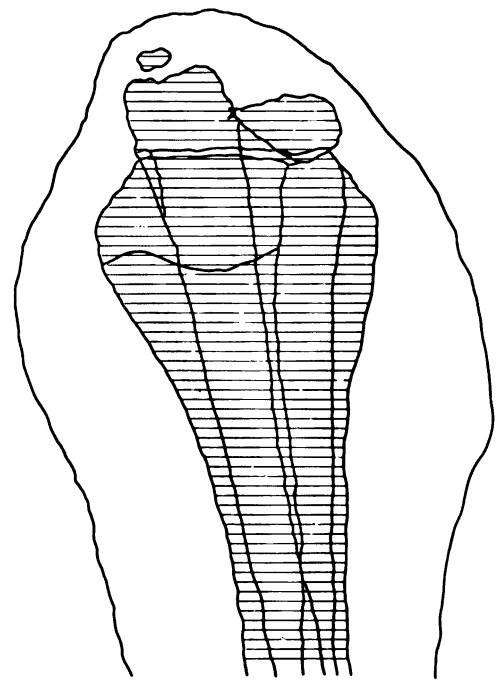

FIG. 26.—A.P. elbow in acute flexion (result).

above and below the desired area. The gonads should be shielded.

Large cassettes and films are necessary for larger children and adults needing accurate measurement. Special procedures, such as individual central ray exposure of each joint, slit scanography, use of opaque measuring standards or use of even longer T. F. D. (Target-Film-Distance) are needed. These all require special long cassettes and films.

FEET

The standard anteroposterior and lateral views are recommended for all foot conditions. The anteroposterior view is taken with a 15° cephalad tilt of the tube. Cooperative children with normal feet need only to be steadied at the knee, which has been flexed and raised to allow film contact with the exposure holder. The uncooperative child necessitates two assistants to complete the foot examination. One person holds the patient's knee firmly with both hands and the other assistant holds a piece of balsa splint board across the dorsum of the patient's foot. This procedure prevents rotation and motion and insures uniform contact of the plantar surface of the foot. The lateral foot view is a standard position obtained with assistance or without, depending upon the child.

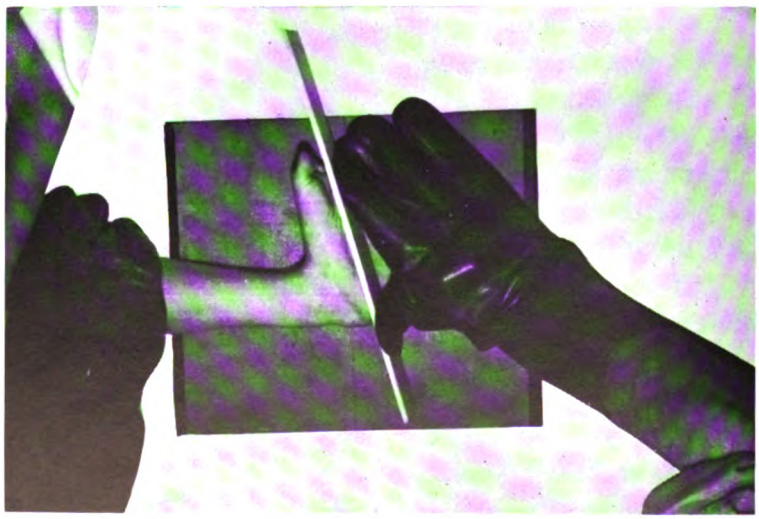

FIG. 27.—Lateral foot, held in maximum dorsiflexion.

Lateral or medial oblique views should be added or substituted for the standard laterals whenever the metatarsals and toes are of primary consideration. This oblique position prevents superimposition of the small distal bones of the feet, and injuries and anomalies are clearly shown.

Two positions are helpful for taking films in the study and treatment of congenital club feet. These are taken both pre-operative and postoperative.

1. These include the standard anteroposterior view with the knees held firmly and evenly and the balsa board held across the feet. No effort is made to straighten out the feet, but the plantar surface is placed in as much contact with the exposure holder as the anomaly will allow.

2. The lateral view is taken with the foot in forced maximum dorsiflexion, with the splint board held firmly against the plantar surface of the foot. Pressure is exerted to force the forefoot upward in order to attain the maximum of dorsiflexion. These positions show the relationship of the astragalus with the other adjacent tarsal bones. (Fig. 27).

Anteroposterior views of the os calcis are recommended in cases of epiphysitis. These may be radiographed in the standing position with the older children. Little children are pronated with the tube horizontal and the film perpendicular. One assistant holds the patient's knee firmly and the other presses the exposure holder or cassette against the plantar surface of the child's foot (Fig. 28).

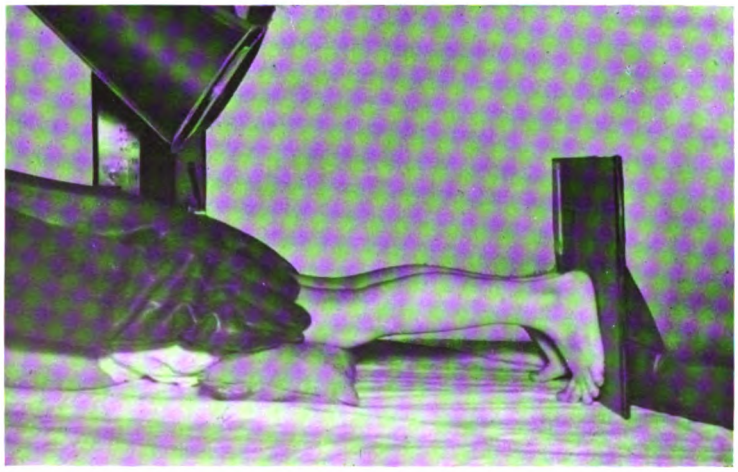

FIG. 28.—A.P. of os calcis, prone position.

The lateral standing position is frequently requested. The patient stands upon a box. The tube is tilted in a horizontal position and the film is held perpendicular.

SURVEYS

Surveys are used to detect either the presence of, or the extent of, localized lesions or to evaluate the degree of involvement of the skeleton in a systemic or generalized disease. Consequently, instead of concentrating on a single anatomical part, certain groups of films are combined.

For the detection of localized lesions, it usually suffices to take single A.P. views, but all the bones must be included. The following is a common plan in this type of survey:

A. A.P. long bones from hip through angle from shoulder through wrists.

B. Single lateral film of the skull.

C. Lateral view of the spine.

D. P.A. of chest.

E. A.P. of abdomen, including pelvis.

This type of survey is commonly used in:

A. Metastatic series in neoplasms or chronic granuloma.

B. Skeletal survey in leukemias and anemias.

C. Preliminary survey in suspected trauma.

D. Skeletal survey for osteochondrodystrophy, mongolism or multiple congenital defects.

The skeleton develops by growth and maturation. Alterations in growth (that biological quality having to do with change in size) are best revealed in the most rapidly growing bones; namely the femur and tibia (knee). Alterations in differentiation or maturation (that biological quality having to do with change in shape) are best demonstrated in the most highly specialized and differentiated bones of the skeleton; namely the hand, for which excellent standards of maturation are available for comparison.

If a systemic or generalized disease is suspected, affecting growth or differentiation, it is common, therefore, not to radiograph the entire skeleton, but take a good representative sample, namely:

P.A. of one hand and wrist.

A.P. of one knee.

(Often on the same split film.)

This procedure is commonly followed in surveys for:

Systemic growth diseases (rickets, scurvy, renal disease, etc.).

Endocrine disorders (hypo- and hyperthyroidism, cretinism, hypopituitarism, etc.).

A child in coma, stupor or convulsions of unknown cause is always suspect of poisoning by ingestion of foreign and toxic material, possibly lead, and a quick radiographic survey is common practice for evaluation.

A.P. and lateral skull (to evaluate the sutures for pressure).

A.P. of abdomen (for evidence of ingested lead or other foreign material).

A.P. of knees (to reveal evidence of chronic growth disturbance).

4

SPECIAL PROCEDURES

I. THE GASTRO-INTESTINAL EXAMINATION

A. Infants

The single barium meal method of gastro-intestinal examination is preferred in infancy.

Food and fluid are withheld for three to four hours prior to the examination. The most important factor ensuring adequate and successful examination is that the infant be sufficiently hungry to ingest barium under direct fluoroscopic visualization.

Two to four ounces of barium sulfate suspension consisting of equal volumes of U.S.P. barium sulfate and sterile 5 per cent glucose in water is prepared in a sterile nursing bottle with sterile nipple for each examination. It is also advisable to have at hand a thick barium sulfate suspension of paste consistency, as described under examination of the heart, should the esophagus be of major interest and the fluid mixture prove unsatisfactory.

In patients with suspected esophageal atresia or other forms of esophageal obstruction or in those presenting a history of repeated aspiration, the use of barium should be avoided. In such instances sterile Lipiodol or a similar preparation may be substituted to advantage since aspiration of such media is of less serious consequence.

Procedure.—The infant is secured to the immobilization device and is fed the radio-opaque material in the supine or right lateral position under direct fluoroscopic visualization. In the supine position, the posteriorly placed fundus of the stomach is dependent, hence the barium suspension outlines this portion and the muscular closing mechanism at the cardio-esophageal junction may be observed. In the prone right posterior oblique position, the antrum fills and the pyloric canal and duodenum may be visualized.

Two assistants, one to administer the barium, both to aid in positioning the infant greatly facilitate the examination. Avoid overfeeding as this inhibits gastric tone and peristalsis, and this delays emptying.

B. CHILDREN

In children over two years of age, the procedure is essentially no different than in the adult. Up to three and a half to four years of age the procedure may have to be performed on the horizontal table; thereafter, examination in both the erect and horizontal positions is generally possible.

Radiographic Technic.—In infants and young children, the stomach is relatively higher than in adults and usually transverse in position with the antrum and the duodenal cap pointing obliquely posteriorly from left to right. Due to this, prone right oblique and right lateral films reveal the stomach and duodenal loop to best advantage. In the oblique, the patient is placed in the prone anterior oblique position with the right side down. The spine is centered just to the right of the center line of the table. The film is centered to the lower rib margin and the central ray directed to the center of the film. The lateral stomach is taken with the patient in the right lateral position, *i.e.,* with the patient's right side down. The spine is placed just posterior to the center line of the table. The film is centered at the lower costal margin and the central ray directed to the center of the film.

II. BARIUM ENEMA

Preparation.—A single cleansing enema is given one to three hours prior to the examination.

Procedure.—The child is secured to the immobilization device. A soft rubber catheter of the largest size that fits the anal orifice with ease is a suitable enema tip. The buttocks may be taped together after insertion of the enema tip. An aqueous suspension of U.S.P. barium sulfate 50 per cent by volume is used as the radio-opaque medium. Two tablespoons of crude powdered tannic acid per quart of enema fluid may be added to improve the mucosal pattern demonstrated in the post-evacuation film. The barium is allowed to flow into the colon under direct fluoroscopic examination. An assistant with gloved hand, or with a lead shield between the patient and tube holds the buttocks

firmly together to prevent premature expulsion of the enema in infants and young children.

Radiographic Technic.—After the colon is filled under direct fluoroscopic visualization, a single anteroposterior film of the abdomen is taken following the described abdominal technic, adding 4 to 6 kilovolts for the additional opacity produced by the barium. Following evacuation, anteroposterior post-evacuation film is taken using standard abdominal technic.

III. HEART FLUOROSCOPY

Fluoroscopy of the heart yields information which films do not provide. Films record but momentary phases of the dynamic cardiovascular cycle. At fluoroscopy, the configuration of the heart can be visualized in all projections, and the rate, rhythm, and amplitude of beat may be observed. In addition the posterior border of the heart shadow can be clearly outlined by the use of ingested barium as the normal esophagus follows the posterior heart border, more specifically the left auricle, intimately.

Preparation. A. Infants.—The preparation and type of barium mixture used is the same as described under Gastro-intestinal Examination, p. 46.

B. Children.—No preparation is necessary. In children, a barium paste (prepared by mixing equal volumes of cocoa, sugar and barium, with sufficient water added to produce a paste consistency) makes a desirable medium that is palatable and passes slowly down the esophagus, permitting its course to be well visualized.

IV. INGESTED RADIO-OPAQUE FOREIGN BODIES

A survey for ingestion or aspiration of foreign bodies in childhood must include the entire gastro-intestinal and respiratory tract in anteroposterior and lateral projections from the nares through the rectum. This should include at least:

1. A.P. or P.A. of chest.
2. Single lateral chest (to include mouth, nares and neck).
3. A.P. of abdomen.
4. Lateral of abdomen to include rectum.

V. FOREIGN BODIES IN TRACHEO-BRONCHIAL TREE

Radio-opaque foreign bodies are readily visualized and localized with standard posteroanterior and lateral films of the chest. Non-radio-opaque foreign bodies manifest themselves only indirectly by differences in aeration secondary to bronchial obstruction, namely atelectasis and obstructive emphysema. If the obstruction is complete, the air exchange of that portion of the lung corresponding to the distribution of the involved bronchus is interrupted. The trapped air in this portion of the lung is rapidly absorbed and it collapses producing a readily identifiable shadow by virtue of the contrasting, radiolucent air-containing lung. This is the sequence of events producing atelectasis.

A partial bronchial obstruction is evidenced by obstructive emphysema. Inspiration is a powerful, forceful action whereas expiration is a passive phenomenon. A partial obstruction therefore restricts the flow of air far more during expiration than during inspiration. In addition, the bronchi dilate during inspiration and contract during expiration thus increasing the degree of obstruction in the expiratory phase. For these reasons, the volume of air flow past the point of obstruction is constantly greater on inspiration than expiration. As a result, the portion of lung supplied by the involved bronchus becomes hyper-aerated or emphysematous. Since it contains more air, such emphysematous lung is more radiolucent than the adjacent normal lung. At full expiration, the difference in density is maximal since the normal lung de-aerates but the emphysematous portions remain hyper-aerated. With minimal degrees of obstruction, emphysema may be seen only transiently during expiration.

These changes are most readily detected at fluoroscopy with films taken to record the findings. From the above discussion, it is clear that inspiratory and expiratory anteroposterior or posteroanterior films together with a lateral film are the minimum necessary for proper evaluation.

Standard chest technic is used. The exposures are timed so that one is taken at full inspiration and one at full expiration. This is best done when the patient is crying and thus is making maximal inspiratory and expiratory efforts. Cooperation in this respect is generally readily obtained.

VI. TRACHEOGRAMS

Tracheography consists of outlining the walls of the trachea by instillation of a radio-opaque medium which adheres to the tracheal wall. This examination is performed in search of obstruction or deformities of the trachea, produced either within the trachea or by pressure from adjacent structures.

Preparation.—1. Food and fluid by mouth are withheld; four to six hours in children, three to four hours in infants.

2. Children over two years of age must be prepared for general anesthesia. Infants require no further preparation, as anesthesia is not required.

3. During the course of the examination, a suctioning apparatus

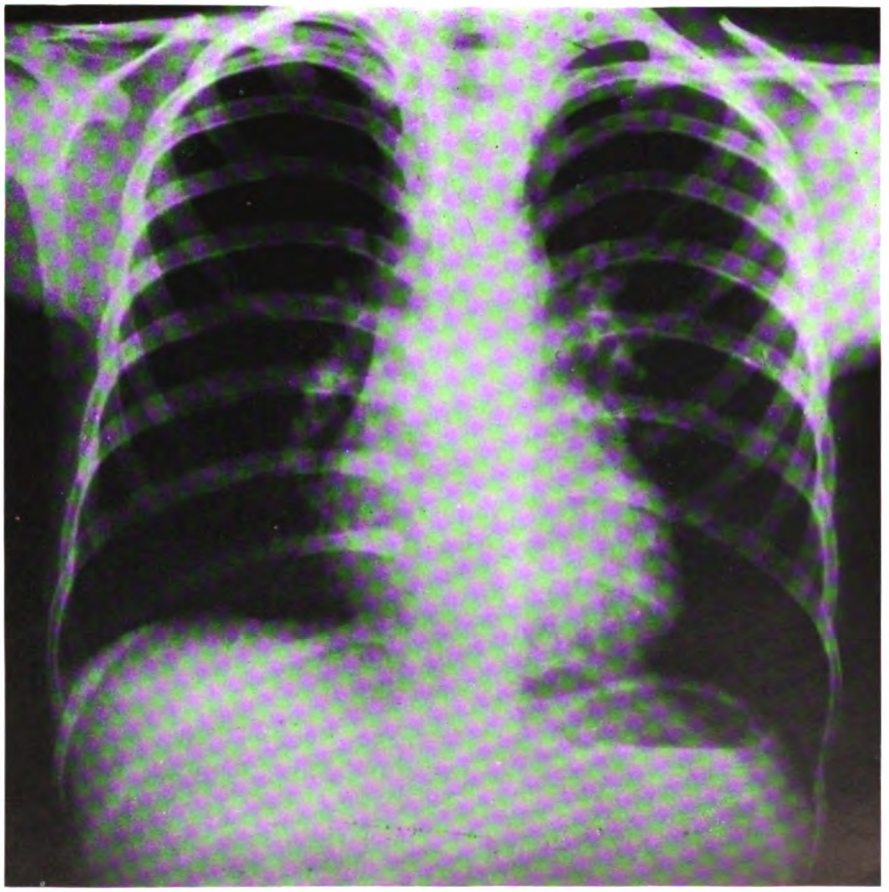

FIG. 29.—P.A. chest @ inspiration (result).

with a metal catheter of sufficient length to pass through the laryngoscope, should be at hand.

Procedure.—With the patient in the supine position and the cassette in place, the operator inserts the laryngoscope, through which a thin metal catheter is passed into the trachea to a point approximately an inch beyond the vocal chords. The opaque medium is then injected through the catheter. The instruments are withdrawn. The patient is immediately rotated into a lateral position, the arms being held rigidly on either side of the head.

Lateral, A.P., right and left posterior oblique films of the chest, including the neck, are then taken as rapidly as possible and preferably in the order named: The most informative projections are thus taken first.

Immediately after the films are taken, the patient is placed in the prone position to facilitate drainage and minimize aspiration.

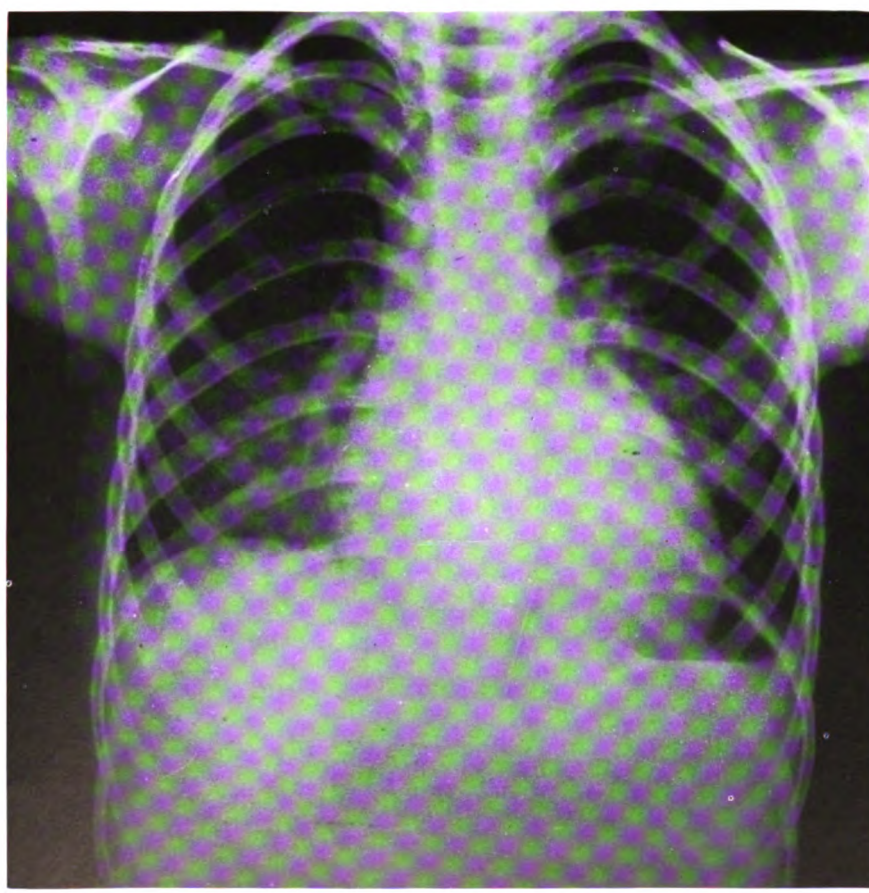

FIG. 30.—P.A. chest @ expiration (result).

VII. BRONCHOGRAPHY

Bronchograms are similar to tracheograms except that in addition an effort is made to coat the walls of the bronchi as well, in order to outline their distribution and configuration.

Preparation.—Same as for tracheograms.

Procedure.—1. Direct Instillation. This technic is identical with that described under tracheograms, except that the opaque medium is directed under fluoroscopic control by positioning and gravity, into the various branches of the tracheal tree.

2. Catheter Technic. A small rubber or plastic catheter with syringe attached to one end may be passed through the nose into the lower pharynx. It may be directed through the larynx either with fluoroscopic guidance, or under direct visualization by the use of a laryngoscope and laryngeal alligator forceps. The catheter may then be passed into the trachea and directed into either main bronchus. With the tip of the catheter lying opposite the orifices of the branches of the main bronchi ¼ to ½ cc. of opaque medium may then be injected under direct fluoroscopic guidance and allowed to pass into the bronchial tree by gravity. This technic is used only if one lung or a single lobe of a lung is to be outlined.

Technic.—Chest films are taken in rapid succession as described under tracheograms.

At completion of the examination, the patient is placed in the prone position preferably with head lowered to permit the maximum amount of opaque medium to drain out of the tracheo-bronchial tree.

VIII. RHINOGRAMS

This examination is performed to outline the nasal canal to demonstrate any deformity thereof or an obstruction of the posterior nares or choanae. The examination must be limited to either the right or left half of the nose at one time.

Procedure.—1. The patient is examined in the supine position.

2. A nasal catheter is inserted into the nostril under examination, and 5 to 10 cc. of opaque medium injected.

Technic.—A lateral view of the nasopharynx is taken with the head in the supine position, the film held against the side of the face under examination, and a horizontal beam directed perpendicular to the cassette and centered about half way between the external auditory canal and the nares.

Following the first exposure an A.P. view is taken using the Bucky diaphragm with the central ray directed through the nose following A.P. skull technic. The film must be taken in the antero-posterior position to prevent spillage of the opaque medium out of the nares.

IX. INTRAVENOUS UROGRAPHY

This examination yields information regarding renal morphology and function by outlining the collecting and transporting system of the urinary tract, namely the renal calyces, pelves and bladder, giving information as to their size, shape and position. The excretory capacity of each kidney may be roughly judged by the appearance time and concentration of the injected radio-opaque medium as it is being excreted by each kidney.

Preparation.—Fluid is usually withheld from four to six hours prior to the examination. The colon may be cleansed by the use of a cathartic and an enema. However, for emergency procedures both of these preparations may be cancelled. At an increasing number of hospitals all forms of preparation for intravenous urography have been dropped.

Important Accessories

1. A table top compression band.
2. An arm board, to prevent the child from flexing an elbow during injection.
3. A shaving kit, for use in preparing the scalp veins when those of the arm, leg or foot are inadequate.
4. A stationary grid or grid cassette.
5. A carbonated beverage to inflate the stomach and produce a homogeneous shadow with infants.

Procedure.—The examination is preceded by a preliminary survey. A.P. film of the abdomen which is reviewed by the radiologist to determine if the kidney shadows are visible. If obscured by bowel content, an enema or further preparation may be necessary. The patient's history

is reviewed for evidence of allergic manifestations or previous reactions. If there is a definite history of hives, hay fever or asthma, the possibility of a sensitivity reaction to the radio-opaque media is sufficiently increased to justify re-evaluation of the indications for the examination in light of this possible hazard. If the equivalent amount of information can be secured by methods other than intravenous urography, this would be the desirable course.

There has been an increased tendency to discontinue testing for sensitivity to the radio-opaque media by conjunctival or intradermal tests since there is poor correlation between the test results and subsequent presence or absence of reactions.

The screening of patients for potential sensitivity by seeking a history of previous allergy has appeared more promising. In any case, it is desirable to have at hand at the time of intravenous urography, antihistamines, epinephrine, oxygen and cortisone with the appropriate equipment for administration and a physician familiar in their use.

The known allergic or sensitive patient presents a special medical problem, but need not be denied the examination indicated if prepared for the procedure by the use of antihistamines and cortisone preparations under the direct supervision of the attending physician.

The type of injection, radio-opaque media and actual injection is the choice of the responsible physician. Intravenous injection is to be preferred for the consistency of high diagnostic quality. The first one half cc. should be injected slowly and cautiously with careful observation for a possible reaction; the remainder may be given more rapidly. Intramuscular injection results in a slower and more variable absorption and poor quality films, with the added disadvantage of requiring a divided dose injection in two sites to reduce the hazard of sterile abscess formation.

Hypaque (50%), Renografin (60%) and Urokon (30% or 70%) have been the most popular media in recent years. Specific directions and dosage schedules are included in the information supplied by the manufacturer. A dosage schedule which has proven successful for Hypaque (50%) and Renografin (60%) follows:

Dosage Chart: For intravenous injection

Newborn to six months	7 cc.
Six months to two years	10 cc.
Two years to three years	15 cc.
Three years to sixteen years	20 cc.

Following the injection, serial A.P. films of the abdomen are taken to observe the excretion of the dye, which normally appears in satisfactory concentration at three minutes. The time intervals at which films are taken are determined by the radiologist. A popular schedule is post-injection films at three and five minutes, at which time the films are viewed by the radiologist who decides if more films are needed. Films should be labeled with the time at which they were taken after the injection of the medium. The pelvis is commonly shielded on the initial post-injection films and the bladder included on the later film, without shielding.

Technical Considerations. A successful intravenous examination affords a technician considerable satisfaction. Many steps must be taken from the beginning of the procedure to its conclusion. With little children these steps are unusually difficult. The technician not only must keep the time intervals in mind, but must constantly be alert for a deviation from a centered position and for involuntary or voluntary movement. An imperfect early exposure can never be repeated later since excretion continues rapidly and time marches on.

X. RETROGRADE PYELOGRAPHY

This examination serves to outline the renal calyces, pelves, and ureters by means of retrograde injection of the contrast medium. It is employed when visualization of these structures is not otherwise possible due to poor concentration of the medium in the intravenous method, or when sensitivity to the medium precludes its intravenous use. This method is advantageous in that the upper urinary tract is outlined very densely and sharply, with excellent detail. In addition, at the time of ureteral catheterization separate urine specimens may be obtained from each kidney.

Preparation.—Food and fluid are withheld for four to six hours prior to the examination. A cleansing soapsuds enema is given within two hours of the examination. The examination is performed under general anesthesia.

Procedure.—Following cystoscopic visualization of the urethra, bladder and ureteral orifices, the ureteral catheters are passed on into each ureter and separate urine specimens are collected. An initial survey film of the abdomen is taken to determine the exact position of the ureteral catheter. The ureteral catheters are usually initially passed

into the ureters for a distance corresponding to half the distance from the symphysis pubis to the umbilicus of the patient.

Following the survey film, direct injection of the radio-opaque medium through the ureteral catheters is made and the survey film of the abdomen is repeated. Twelve per cent sodium iodide, Pyelokon, Hypaque or similar materials may be used. Three to five cc. are usually injected in infants; 5 to 10 cc. in children. Following review of these films, further views may be desired, including obliques.

XI. CYSTOGRAMS AND URETHROGRAMS

This examination either alone or in combination is used to demonstrate the lower urinary tract, that is, the urinary bladder and the urethra by direct retrograde instillation of radio-opaque dye. The examination may be performed without sedation or anesthesia except on children between the ages of two to four, from whom active cooperation may not be expected.

Preparation.—Mild preliminary sedation may be used if desired.

Procedure.—The patient is placed in the A.P. position on the *x*-ray table. The film is centered over the pelvis and the patient is catheterized by the physician using aseptic technic. The bladder is emptied and four per cent sodium iodide or similar suitable radio-opaque medium is then injected through the catheter in an amount sufficient to fill the bladder to a mild degree of distention. The catheter is clamped off and while still in place, A.P. and lateral films are taken following the prescribed technic for pelvis and lateral lumbar spine with the central beam centered over the pelvis.

VOIDING URETHROGRAMS.—These may be secured as a follow-up of the cystogram. With the catheter withdrawn, a film is taken while the patient voids the injected radio-opaque medium. The preferred position is either a left or a right posterior oblique with the patient's under leg flexed and abducted and the upper leg extended to prevent overlap of the femur upon the lower urinary tract. Precise timing is essential to success.

RETROGRADE URETHROGRAMS.—With the patient in either left or right posterior oblique positions as described above, retrograde injection of the urethra may be performed in cases difficult to catheterize. Twelve per cent sodium iodide or similar radio-opaque medium is used by direct injection with either the tip of a rubber catheter or a cysto-

FIG. 31.—Retrograde urethrogram (result).

scope tip passed into the external urethral meatus approximately ½ to 1 inch and held in position during the injection of the medium. When the injection of the content of the syringe is almost complete, the film should be taken, thus demonstrating the urethra at maximum distention. A stationary grid is preferable to the usual Potter-Bucky diaphragm in patients up to seven years of age. This grid provides better soft tissue detail by eliminating the blurring secondary radiation of the lower voltages with less loss of speed.

Radiographic technic factors are listed under Technic, Cystograms and Urethrograms, pp. 67 and 86.

XII. NEPHROSTOGRAMS

Nephrostograms may be performed by the retrograde injection of four per cent sodium iodide or similar radio-opaque media through the nephrostomy drainage tube. The initial A.P. exposure should be taken during the actual injection to demonstrate the renal pelvis fully distended. Thereafter, the patient may be placed in a sitting position for a suitable interval, and a repeat examination may be performed to demonstrate dependent drainage from the pelvis.

XIII. ENCEPHALOGRAMS AND VENTRICULOGRAMS

This procedure is used to demonstrate the internal chambers of the brain by withdrawal of cerebrospinal fluid, and its replacement with air. The air acts as a contrast medium. Due to radiolucency the chambers, if properly filled, may be satisfactorily visualized.

The examination is performed in children under full anesthesia and the preparation for the selected anesthetic agent is used.

Procedure.—ENCEPHALOGRAMS. Under anesthesia, the patient is supported in the upright position, preferably with the head supported by a head sling attached to the ceiling by a hook and adjustable support. The head support is unnecessary for small infants as they may be supported by a pillow or blanket folded under the arms and against the abdomen. Following the accepted procedure for spinal tap, the cerebro-spinal fluid is withdrawn from the spine by gravity. At this time a sterile specimen may be collected for laboratory study. By use of a three-way stopcock, the spinal fluid is intermittently replaced by the injection of air drawn into the syringe through a sterile sponge. The spinal fluid drainage is carried on to complete this, or until 110 cc. of fluid have been removed. Only rarely is more than 110 cc. of fluid removed in a child of four or more years of age. For younger children, the amount is proportionately less.

While in the upright position, the head is moved in varying degrees of tilt to facilitate drainage of fluid, and aid in the proper distribution of the air. After the air injection is complete, the needle is withdrawn and a sterile dressing placed over the lumbar puncture site, and the patient is ready for radiographic study.

VENTRICULOGRAMS.—This procedure is also used to demonstrate the internal chambers or ventricles of the brain, but the route of injection differs, the air being injected directly into the ventricles rather than into the spinal subarachnoid space and should be used in all cases suspected of having a block or obstruction in the spinal canal and in all cases presenting evidence to suggest intracranial pressure. If this precaution is not observed, serious complications may result with herniation of the brain stem into the foramen magnum of the skull due to the unbalanced distribution of pressure within the cerebrospinal system. In infancy, the physician may inject air into the ventricles through the open fontanelles or open sutures. In older children, the injection is usually performed through burr holes in the

parietal bones of the skull opposite the ventricles. *The radiographic technic is similar to that of the routine skull examination.* The minimum positions recommended for satisfactory diagnostic studies are: A.P., P.A., right and left lateral films of the skull preferably stereoscopic, and an upright anteroposterior film.

XIV. INTRACRANIAL AIR BUBBLE STUDIES

This examination has been especially devised for the intracranial ventricular system of hydrocephalic children. In hydrocephalus the ventricles are obstructed and dilated and complete withdrawal of fluid and replacement by air is a very hazardous procedure as the thin wall of the brain may collapse if the fluid is withdrawn from the ventricles. Therefore, only a small volume of air is injected into the ventricular system. The extent and shape of the ventricles are studied by the displacement of the single bubble within the ventricles during various positions of the head. As these studies are usually performed on small infants, no anesthetic is customary. By direct ventricular tap, the physician usually withdraws 10 cc. of cerebrospinal fluid at a time and replaces this with sterile air by means of a syringe. At least 20 cc. and no

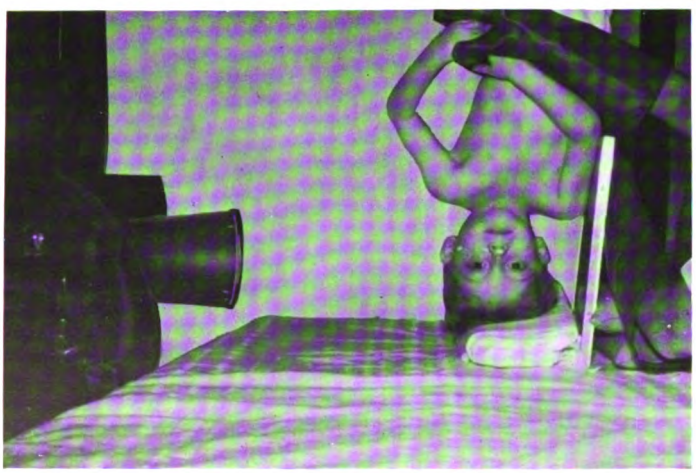

FIG. 32.—Lateral skull with patient inverted.

more than 50 cc. of cerebrospinal fluid are removed and replaced by a similar amount of air. The needle is withdrawn. The puncture site is covered with a sterile gauze, and the patient is ready for radiographic studies.

Radiographic Technic.—Hydrocephalic cranial vaults vary considerably in size ranging from a slight increase to those of three, four, or five times normal size. Age group kilovoltage tables are therefore unsatisfactory due to this variation in size. The time factor must be kept low, and technical factors are recommended under "Air Bubble Studies," p. 71.

Multiple positions of the head are necessary in this examination in order that the injected air bubble may reach all the extremities of the ventricular system. The following skull positions are customary:

1. A.P. view of the skull.
2. Lateral view of the skull with the patient supine, the *x*-ray beam horizontal, and the cassette perpendicular to the beam.
3. A lateral view with the patient prone, the *x*-ray beam horizontal, and the cassette perpendicular to the beam.
4. A lateral view with the patient inverted, and supported by the hips and knees, and the chin steadied to prevent rotation, the beam horizontal and the cassette perpendicular.
5. An anteroposterior view in the upright position.

5

CHILDREN'S TECHNIC

THE following alphabetically listed technic was compiled from an experience of over twenty years with a 500 MA machine at a children's hospital. During this period more than 500,000 exposures have been accumulated, including all varieties of radiographic procedures. The technical factors were grouped about twenty years ago, in a loose-leaf book, and have been used successfully since that time by residents and student technicians. They are presented intact, with the addition of an alternate time section for those not so fortunate as to have high-speed apparatus with rotating anode tubes. Medium, or par-speed screens were used exclusively.

The unorthodox procedure of segregating technic into age groups has proven advantageous with the variation of 3 to 5 KV for the lower and upper limits of each group.

The introduction of improved high-speed intensifying screens and uniform fast films has enabled radiographic departments to reduce the MAS on any given exposure by 75 per cent when both of these improvements have been employed or to reduce the MAS by 50 per cent when either of these factors has been used.

Since these high-speed factors are not universally used in their entirety, the children's technical tables with the previously determined use of par-speed screens and par-speed films remain as a standard base-line. (See Chapter 2—Note 3.)

For each high-speed factor used (High-speed screens, high-speed films, 5 minute developing at 68°) divide MAS of table by 2. Therefore, if all are used, divide by 8. Minor adjustments in density can be accomplished with small changes in KVP.

ABDOMEN *

Suggested positions—Standard—A.P. recumbent—including diaphragms, kidneys, ureters, and bladder. Additional positions—upright—for intestinal obstruction; lateral views for abdominal tumors and masses.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
	A.P.	40–43	300	5.	40	1/60	1/20	no bucky no grid
Birth to 3 mos.	Lat.	45–48	300	5.	40	1/60	1/20	no bucky no grid
	Upright	46–50	300	5.	40	1/60	1/20	no bucky no grid
	A.P.	53–56	300	7.5	40	1/40	1/15–1/10	using grid
	Lat.	58–62	300	10.	40	1/30	1/10	using grid
	Upright	56–59	300	7.5	40	1/40	1/15–1/10	using grid
	A.P.	42–46	300	5.	40	1/60	1/20	no bucky no grid
3 mos. to 2 yrs.	Lat.	49–54	300	5.	40	1/60	1/20	no bucky no grid
	Upright	50–55	300	5.	40	1/60	1/20	no bucky no grid
	A.P.	53–56	300	10.	40	1/30	1/10	using grid
	Lat.	62–65	300	10.	40	1/30	1/10	using grid
	Upright	56–59	300	10.	40	1/30	1/10	using grid
	A.P.	65–70	200	10.	40	1/20	1/10	using bucky
2 to 5 yrs.	Lateral	65–70	200	20.	40	1/10	1/5	using bucky
	Upright	68–72	200	10.	40	1/20	1/10	using bucky tilt table
	A.P.	60–65	200	20.	40	1/10	1/5	using bucky
5 to 7 yrs.	Lateral	65–70	200	40.	40	2/10	2/5	using bucky
	Upright	65–70	200	20.	40	1/10	1/5	using bucky
	A.P.	55–60	200	50.	40	1/4	1/2	using bucky
7to12 yrs.	Lateral	65–70	200	50.	40	1/4	1/2	using bucky
	Upright	60–65	200	50.	40	1/4	1/2	using bucky

NOTES.—*A*, Special examinations—1. Cystogram and urethrogram; 2. G.I. series; 3. barium enema; 4. I.V. urograms. Please refer to each under individual heading.

B, Alternate technics for little children—1. Without Bucky diaphragm or stationary grid; 2. Using Bucky or grid. The speed gained with the first grouping may be advantageous, as secondary radiation is minimal.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

ANKLE *

Suggested positions: 1. Anteroposterior; 2. Lateral view; 3. Lateral oblique, for injuries to lateral, or external malleolus.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.-Lat. & Oblique	40-43	200	3.33	40	1/60	1/30	using cassette
3 mos. to 2 yrs.	A.P.-Lat. & Oblique	43-46	200	3.33	40	1/60	1/30	using cassette
2 to 5 yrs.	A.P.-Lat. & Oblique	46-49	200	3.33	40	1/60	1/30	using cassette
5 to 7 yrs.	A.P.-Lat. & Oblique	49-52	200	3.33	40	1/60	1/30	using cassette
7to12 yrs.	A.P.-Lat. & Oblique	49-52	200	5.	40	1/40	1/20	using cassette

NOTE.—*A*, Ankles in plaster; double time and add 5–15 K V. to standard settings.

BARIUM ENEMA

Suggested positions: 1. Anteroposterior views immediately after fluoroscopy with colon filled, and A.P. view post-evacuation; 2. Lateral or oblique views as requested.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. filled	57-62	300	5.	40	1/60	1/20	no bucky
	Lat. filled	57-62	300	7.5	40	1/40	1/15	no bucky
	A.P. post evac.	52-57	300	5.	40	1/60	1/20	no bucky
3 mos. to 2 yrs.	A.P. filled	57-62	300	7.5	40	1/40	1/15	no bucky
	Lat. filled	57-62	300	10.	40	1/30	1/10	no bucky
	A.P. post evac.	52-57	300	7.5	40	1/40	1/15	no bucky
2 to 5 yrs.	A.P. filled	65-70	200	6.67	40	1/30	1/15	no bucky
	Lat. filled	65-70	200	10.	40	1/20	1/10	no bucky
	A.P. post evac.	60-65	200	6.67	40	1/30	1/15	no bucky
5 to 7 yrs.	A.P. filled	68-72	200	30.	40	3/20	3/10	using bucky
	Lat. filled	70-75	200	30.	40	3/20	3/10	using bucky
	A.P. post evac.	63-67	200	30.	40	3/20	3/10	using bucky
7to12 yrs.	A.P. filled	70-75	200	50.	40	1/4	1/2	using bucky
	Lat. filled	73-78	200	50.	40	1/4	1/2	using bucky
	A.P. post evac.	65-70	200	50.	40	1/4	1/2	using bucky

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

BRONCHOGRAMS AND TRACHEOGRAMS *

Suggested positions: Bronchograms—1. Either posteroanterior or anteroposterior; 2. Right posterior oblique; 3. Left posterior oblique; 4. Lateral with affected lung down; 5. Either right or left anterior oblique with affected lung down.

Tracheograms.—1. Lateral position taken immediately of chest and neck after injection of medium, with arms held on either side of head; 2. Anteroposterior view of chest and neck following the lateral view.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*	
Birth to 3 mos.	P.A. or A.P.	43–46	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Obliques	49–52	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Lateral	55–58	400	6.67	40	1/60	1/15	Recumbent	No bucky
3 mos. to 2 yrs.	P.A. or A.P.	45–50	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Obliques	52–55	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Lateral	60–65	400	6.67	40	1/60	1/15	Recumbent	No bucky
2 to 5 yrs.	P.A. or A.P.	50–55	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Obliques	55–58	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Lateral	65–70	400	6.67	40	1/60	1/15	Recumbent	No bucky
5 to 7 yrs.	P.A. or A.P.	55–58	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Obliques	58–61	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Lateral	70–73	400	6.67	40	1/60	1/15	Recumbent	No bucky
7to12 yrs.	P.A. or A.P.	57–62	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Obliques	61–66	400	6.67	40	1/60	1/15	Recumbent	No bucky
	Lateral	72–78	400	6.67	40	1/60	1/15	Recumbent	No bucky

NOTES.—*A*, Above figures app. 5 K V above comparative chest exposures.
B, Apparatus whose max. M.A. = 200; double time factor or add 12 K V.
C, *See* special procedures for explanation of procedure, positions, *etc.*

CEREBRAL ANGIOGRAM *

Suggested positions: 1. Lateral stereoscopic films of either side of skull taken separately and immediately with each injection of 10 cc. of contrast media; 2. A.P. view.

Age group	*Position*	*K V*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	Laterals	53–56	200	20.	40	1/10	2/10	using bucky
	A.P.	60–63	200	20.	40	1/10	2/10	using bucky
3 mos. to 2 yrs.	Laterals	56–60	200	20.	40	1/10	2/10	using bucky
	A.P.	63–66	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	Laterals	56–60	200	30.	40	3/20	3/10	using bucky
	A.P.	63–66	200	30.	40	3/20	3/10	using bucky
5 to 7 yrs.	Laterals	60–65	200	30.	40	3/20	3/10	using bucky
	A.P.	67–72	200	30.	40	3/20	3/10	using bucky
7to12 yrs.	Laterals	65–70	200	30.	40	3/20	3/10	using bucky
	A.P.	73–78	200	30.	40	3/20	3/10	using bucky

NOTES.—*A*, It is suggested that radiographic departments with 100 M.A. maximum equipment, use the preferred time listed, and compensate by adding 12 K V.
B, *See* special procedures, for explanation of procedure, positions, *etc.*
C, Rapid dissipation of opaque media necessitates 3/20 sec. as maximum time advisable.

*Par-speed screens, Par-speed film, 3 min. developing, 68° F.

CERVICAL SPINE *

Suggested positions: 1. Anteroposterior with chin elevated and tube tilted 5–10° cephalad; 2. Lateral view, either supine, sitting or standing; 3. Obliques in specific cases; 4. Lateral view using Bucky Diaphragm; 5. Open mouth A.P. spot projection to visualize axis and odontoid.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
	A.P.	50–53	200	3.33	40	1/60	1/30	lying supine
Birth to 3	Lateral	52–55	200	3.33	40	1/60	1/30	lying supine
mos.	Obliques	52–55	200	3.33	40	1/60	1/30	lying supine
	Odontoid	50–53	200	3.33	20	1/60	1/30	lying supine
	Lat.	55–58	200	10.	40	1/20	1/10	lying lateral using bucky
	A.P.	53–58	200	3.33	40	1/60	1/30	lying supine
3 mos. to	Lateral	55–60	200	3.33	40	1/60	1/30	lying supine
2 yrs.	Obliques	55–60	200	2.33	40	1/60	1/30	lying supine
	Odontoid	53–58	200	3.33	20	1/60	1/30	lying supine
	Lat.	58–63	200	10.	40	1/20	1/10	lying lateral using bucky
	A.P.	50–55	200	20.	40	1/10	2/10	using bucky
	Lateral	60–65	200	6.67	72	1/30	1/15	standing or sitting-no bucky
2 to 5 yrs.	Obliques	52–57	200	20.	40	1/10	2/10	using bucky
	Odontoid	50–55	200	20.	20	1/10	2/10	using bucky
	Lat.	50–55	200	20.	40	1/10	2/10	lying lateral using bucky
	A.P.	55–60	200	20.	40	1/10	2/10	using bucky
	Lateral	65–68	200	10.	72	1/20	1/10	standing or sitting-no bucky
5 to 7 yrs.	Obliques	57–60	200	20.	40	1/10	2/10	using bucky
	Odontoid	59–62	200	20.	40	1/10	2/10	using bucky
	Lat.	55–60	200	20.	40	1/10	2/10	lying lateral using bucky
	A.P.	60–65	200	20.	40	1/10	2/10	using bucky
	Lateral	68–70	200	10.	72	1/20	1/10	standing or sitting-no bucky
7 to 12 yrs.	Obliques	60–65	200	20.	40	1/10	2/10	using bucky
	Odontoid	62–67	200	20.	40	1/10	2/10	using bucky
	Lat.	60–65	200	20.	40	1/10	2/10	lying lateral using bucky

NOTES.—*A*, Patients in plaster casts; double time and add 5–15 K V., depending on thickness of cast.

B, Refer to neck for soft tissue technic.

C, 20 inch distance desirable for spot film of odontoid area on little children.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

CHEST AND HEART*

Suggested positions: Chest.—1. Posteroanterior; with infants, anteroposterior may be substituted; 2. Lateral view; 3. A left posteroanterior oblique view should be added in tuberculosis suspects; 4. Anteroposterior view using Bucky Diaphragm.

Heart.—1. A posteroanterior view taken at 72 inches; 2. A lateral view at 40 inches taken with or without a swallow of barium. 3. Posteroanterior oblique views of either side with or without barium.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A. or A.P.	38-42	400	6.67	40	1/60	1/20-1/15	prone or supine inspiration
	P.A. heart	49-52	400	6.67	72	1/60	1/20-1/15	prone or supine inspiration
	Lateral	50-55	400	6.67	40	1/60	1/20-1/15	prone or supine inspiration
	Oblique	42-46	400	6.67	40	1/60	1/20-1/15	prone or supine inspiration
	A.P. view	55-60	200	10.	40	1/20	1/10	passive expiration using bucky
3 mos. to 2 yrs.	P.A. or A.P.	42-46	400	6.67	40	1/60	1/20-1/15	upright preferred
	P.A. heart	52-55	400	6.67	72	1/60	1/20-1/15	upright preferred
	Lateral	55-60	400	6.67	40	1/60	1/20-1/15	upright preferred
	Oblique	47-52	400	6.67	40	1/60	1/20-1/15	upright preferred
	A.P. view	60-63	200	10.	40	1/20	1/10	passive expiration using bucky
2 to 5 yrs.	P.A. or A.P.	47-52	400	6.67	72	1/60	1/20-1/15	upright preferred
	Lateral	57-62	400	6.67	40	1/60	1/20-1/15	upright preferred
	Oblique	52-57	400	6.67	40	1/60	1/20-1/15	upright preferred
	A.P. view	63-68	200	10.	40	1/20	1/10	passive expiration using bucky
5 to 7 yrs.	P.A. or A.P.	47-52	400	10.	72	1/40	1/10	upright inspiration
	Lateral	59-64	400	10.	40	1/40	1/10	upright inspiration
	Oblique	52-57	400	10.	40	1/40	1/10	upright inspiration
	A.P. view	60-65	200	20.	40	1/10	2/10	passive expiration using bucky
7to12 yrs.	P.A. or A.P.	52-57	400	10.	72	1/40	1/10	upright inspiration
	Lateral	64-69	400	13.33	40	1/30	1/8	upright inspiration
	Oblique	57-62	400	10.	40	1/40	1/10	upright inspiration
	A.P. view	65-70	200	30.	40	3/20	3/10	passive expiration using bucky

NOTES.—*A*, Alternate time @ 1/20 needs 5 K V. increase to compensate for loss of 1.67 M A S.

B, Non-opaque foreign body studies need A.P. views @ inspiration and expiration.

C, Tracheo-esophageal fistulas warrant slight KV. increase after instillation of medium.

D, Special Examinations.—bronchograms and foreign bodies, please refer to each under individual heading.

E, Apparatus whose max. M A. = 200; please double time factor or add 12 K V.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

CYSTOGRAM *

Suggested positions: 1. Anteroposterior, using cassette large enough to include kidneys, ureters, and bladder; 2. Lateral view with above areas included.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	63-66	200	6.67	40	1/30	1/15	using grid
	Lateral	65-70	200	10.	40	1/20	1/10	using grid
3 mos. to 2 yrs.	A.P.	65-70	200	10.	40	1/20	1/10	using bucky
	Lateral	65-70	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	A.P.	62-67	200	20.	40	1/10	2/10	using bucky
	Lateral	65-70	200	40.	40	2/10	4/10	using bucky
5 to 7 yrs.	A.P.	62-67	200	30.	40	3/20	3/10	using bucky
	Lateral	65-70	200	60.	40	3/10	6/10	using bucky
7 to 12 yrs.	A.P.	62-67	200	50.	40	1/4	1/2	using bucky
	Lateral	67-72	200	100.	40	1/2	1	using bucky

NOTES.—*A*, *See* cystogram under special procedures for explanation of pre-radiographic technic.

B, Urethrogram under special procedures and technic.

DORSAL SPINE *

Suggested positions: 1. Anteroposterior, either singularly or stereoscopically; 2. Lateral view; 3. Anterior oblique views for D^1 and D^4, with older muscular children.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	63-65	200	5.	40	1/40	1/20	using grid
	Lateral	65-68	200	6.67	40	1/30	1/15	using grid
	Oblique	65-68	200	5.	40	1/40	1/20	using grid
3 mos. to 2 yrs.	A.P.	63-68	200	6.67	40	1/30	1/15	using grid
	Lateral	65-70	200	10.	40	1/20	1/10	using grid
	Oblique	65-70	200	6.67	40	1/30	1/15	using grid
	A.P.	60 65	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	Lateral	60-65	200	30.	40	3/20	3/10	using bucky
	Oblique	63-68	200	20.	40	1/10	2/10	using bucky
	A.P.	60 65	200	30.	40	3/20	3/10	using bucky
5 to 7 yrs.	Lateral	63 68	200	40.	40	2/10	4/10	using bucky
	Oblique	63 68	200	30.	40	3/20	3/10	using bucky
	A.P.	63 68	200	40.	40	2/10	4/10	using bucky
7 to 12 yrs.	Lateral	65-70	200	80.	40	4/10	8/10	using bucky
	Oblique	63 68	200	60.	40	3/10	6/10	using bucky

NOTES.—*A*, Patients in plaster casts—double time and add 5–15 K V. depending on thickness of casts.

B, Scoliosis series, please refer to spines under scoliosis technic.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

ELBOW AND FOREARM *

Suggested positions: 1. Anteroposterior; 2. Lateral; 3. A.P. in acute flexion.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. & Lateral	40–43	200	3.33	40	1/60	1/30	using cassette
	A.P. acute flexion	45–47	200	3.33	40	1/60	1/30	using cassette
3 mos. to 2 yrs.	A.P. & Lateral	43–46	200	3.33	40	1/60	1/30	using cassette
	A.P. acute flexion	50–53	200	3.33	40	1/60	1/30	using cassette
2 to 5 yrs.	A.P. & Lateral	46–49	200	3.33	40	1/60	1/30	using cassette
	A.P. acute flexion	53–58	200	3.33	40	1/60	1/30	using cassette
5 to 7 yrs.	A.P. & Lateral	49–52	200	3.33	40	1/60	1/30	using cassette
	A.P. acute flexion	58–60	200	3.33	40	1/60	1/30	using cassette
7 to 12 yrs.	A.P. & Lateral	49–52	200	5.	40	1/40	1/20	using cassette
	A.P. acute flexion	58–62	200	5.	40	1/40	1/20	using cassette

NOTE.—*A*, double time and add 10–15 K V. in plaster.

ENCEPHALOGRAM AND VENTRICULOGRAM *

Suggested positions: 1. Anteroposterior; 2. Stereoscopic right and left lateral positions; 3. Posteroanterior; 4. Upright anteroposterior.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. & P.A.	60–63	200	20.	40	1/10	2/10	using bucky
	Laterals	53–56	200	20.	40	1/10	2/10	using bucky
	A.P. Upright	63–65	200	5.	40	1/40	1/20	no bucky
3 mos. to 2 yrs.	A.P. & P.A.	63–66	200	20.	40	1/10	2/10	using bucky
	Laterals	56–60	200	20.	40	1/10	2/10	using bucky
	A.P. Upright	65–68	200	5.	40	1/40	1/20	no bucky or grid
2 to 5 yrs.	A.P. & P.A.	63–66	200	30.	40	3/20	3/10	using bucky
	Laterals	56–60	200	30.	40	3/20	3/10	using bucky
	A.P. Upright	65–68	200	6.67	40	1/30	1/15	no bucky or grid
	A.P. Upright	65–68	200	30.	40	3/20	3/10	using stationary grid
5 to 7 yrs.	A.P. & P.A.	63–66	200	40.	40	2/10	4/10	using bucky
	Laterals	56–60	200	40.	40	2/10	4/10	using bucky
	A.P. Upright	67–70	200	6.67	40	1/30	1/15	no bucky or grid
	A.P. Upright	65–68	200	40.	40	2/10	4/10	using stationary grid
7 to 12 yrs.	A.P. & P.A.	63–68	200	50.	40	1/4	1/2	using bucky
	Laterals	56–60	200	50.	40	1/4	1/2	using bucky
	A.P. Upright	67–70	200	10.	40	1/20	1/10	no bucky or grid
	A.P. Upright	67–70	200	50.	40	1/4	1/2	using stationary grid

NOTES.—*A*, To visualize the posterior horns of the ventricles with incomplete filling, a lateral in P.A. position is advised.

B, To visualize the 4th ventricle a lateral in inverted position is advised.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

FEET*

Suggested positions: 1. Anteroposterior, with 15° tilt of tube cephalad; 2. Direct lateral views, standard; 3. Direct lateral views in maximum dorsiflexion with club foot conditions; 4. Oblique lateral views in questionable injuries to metatarsals and toes: 5. Lateral upright views to demonstrate weight bearing; 6. P.A. view of os calcis with central ray projected distally from knees to film, which is placed perpendicular against heels.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. views	67–70	200	10.	40	1/20	1/10	using exposure holders
	Lateral views	65–68	200	10.	40	1/20	1/10	using exposure holders
	All views casts	58–61	200	5.	40	1/40	1/20	using cassette
	A.P. views	67–70	200	20.	40	1/10	2/10	exposure holders
3 mos. to 2 yrs.	Lateral views	65–68	200	20.	40	1/10	2/10	exposure holders
	All views in casts	58–61	200	6.67	40	1/30	1/15	using cassette
	A.P. views	67–70	200	40.	40	2/10	4/10	exposure holders
2 to 5 yrs.	Lateral views	65–68	200	40.	40	2/10	4/10	exposure holders
	All views in casts	58–63	200	6.67	40	1/30	1/15	using cassette
	A.P. views	67–70	200	60.	40	3/10	6/10	exposure holders
5 to 7 yrs.	Lateral views	65–68	200	60.	40	3/10	6/10	exposure holders
	All views in casts	58–63	200	10.	40	1/20	1/10	using cassette
	A.P. views	67–72	200	80.	40	4/10	8/10	exposure holders
7 to 12 yrs.	Lateral views	65–70	200	80.	40	4/10	8/10	exposure holders
	All views in plaster casts	62–65	200	10.	40	1/20	1/10	using cassette

NOTE.—*A*, Consideration should be given to the thickness of the plaster casts, rather than age groups. Above technic applicable to average cast thicknesses.

FEMUR*

Suggested positions: 1. Anteroposterior, including hip and knee joint; 2. Lateral view, with patient in posterior oblique position. This position gives a view of entire shaft; 3. Standard lateral view, with patient on side, and unaffected leg flexed forward.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	40–43	200	5.	40	1/40	1/20	using cassette
	Lateral	40–43	200	5.	40	1/40	1/20	using cassette
3 mos. to 2 yrs.	A.P.	43–46	200	5.	40	1/40	1/20	using cassette
	Lateral	43–46	200	5.	40	1/40	1/20	using cassette
2 to 5 yrs.	A.P.	46–48	200	5.	40	1/40	1/20	using cassette
	Lateral	46–48	200	5.	40	1/40	1/20	using cassette
	A.P.	53–56	200	5.	40	1/40	1/20	using cassette
5 to 7 yrs.	Lateral	53–56	200	5.	40	1/40	1/20	using cassette
	A.P. & Lateral	50–55	200	20.	40	1/10	2/10	cassette & bucky
	A.P.	53–56	200	6.67	40	1/30	1/15	using cassette
7 to 12 yrs.	Lateral	53–56	200	6.67	40	1/30	1/15	using cassette
	A.P. & Lateral	50–55	200	30.	40	3/20	3/10	cassette & bucky

NOTE.—*A*, Patients in plaster—Add 10–15 K V. and double time.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

G. I. SERIES *

Suggested positions: 1. Posteroanterior, using long cassette to include stomach, small intestine, and large bowel; 2. Right anterior oblique to include stomach, especially pylorus and duodenal cap; 3. Any spot variations that findings warrant.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A.	54–57	300	5.	40	1/60	1/20	no bucky or grid
	Oblique	57–62	300	5.	40	1/60	1/20	no bucky or grid
	Fluoroscopic	70	100	1.67	Close	1/60	1/60	using cone if desired
	spot films	70	100		Close			
3 mos. to 2 yrs.	P.A.	54–57	300	5.	40	1/40	1/20	no bucky or grid
	Oblique	57–62	300	5.	40	1/40	1/20	no bucky or grid
	Fluoroscopic	70	100	2.5	Close	1/40	1/40	using cone if desired
	spot films	70	100		Close			no bucky or grid
2 to 5 yrs.	P.A.	62–65	200	6.67	40	1/30	1/15	no bucky or grid
	Oblique	65-70	200	6.67	40	1/30	1/15	no bucky or grid
	Fluoroscopic	70	100	3.33	Close	1/30	1/30	using contact cone if desired
	spot films	70	100		Close			
5 to 7 yrs.	P.A.	62–65	200	40.	40	2/10	4/10	using bucky
	Oblique	65–70	200	40.	40	2/10	4/10	using bucky
	Fluoroscopic	70	100	5.	Close	1/20	1/20	using contact cone if desired
	spot films	70	100		Close			
7to12 yrs.	P.A.	62-68	200	50.	40	1/4	1/2	using bucky
	Oblique	65–72	200	50.	40	1/4	1/2	using bucky
	Fluoroscopic	70	100	10.	Close	1/10	1/10	using contact cone if desired
	spot films	70	100		Close			

HIPS *

Suggested positions: 1. Anteroposterior or posteroanterior, either singularly or stereoscopically; 2. Lateral view of hip taken in abduction and external rotation; 3. Lateral acetabular views with dislocated hip cases.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. & P.A.	62–65	200	5.	40	1/40	1/20	using grid
	Lateral	62–65	200	5.	40	1/40	1/20	using grid
	Acetabular	65–67	200	6.67	40	1/30	1/15	no grid
3 mos. to 2 yrs.	A.P. & P.A.	65–70	200	6.67	40	1/30	1/15	using grid
	Lateral	65–70	200	6.67	40	1/30	1/15	using grid
	Acetabular	65–70	200	6.67	40	1/30	1/15	using no grid
2 to 5 yrs.	A.P. & P.A.	55–58	200	20.	40	1/10	2/10	using bucky
	Lateral	55–58	200	20.	40	1/10	2/10	using bucky
	Acetabular	65–70	200	10.	40	1/20	1/10	without bucky
5 to 7 yrs.	A.P. & P.A.	58–63	200	30.	40	3/20	3/10	using bucky
	Lateral	58–63	200	30.	40	3/20	3/10	using bucky
	Acetabular	70–75	200	13.33	40	1/15	1/8	without bucky
7to12 yrs.	A.P. & P.A.	58–63	200	50.	40	1/4	1/2	using bucky
	Lateral	58–63	200	50.	40	1/4	1/2	using bucky
	Acetabular	70–75	200	30.	40	3/20	3/10	without bucky

NOTES.—*A*, Posteroanterior position suggested for visualization of os pubis.

B, Anteroposterior view for soft tissue detail, decrease 5–10 Kilovolts.

C, Pelvis in plaster casts—double time and add 10–15 K V., depending on thickness of casts.

*Par-speed screens, Par-speed film, 3 min. developing, 68° F.

HUMERUS *

Suggested positions: 1. Anteroposterior; 2. Lateral view, supine, with arm abducted and externally rotated.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	45–48	200	3.33	40	1/60	1/30	using cassette
	Lateral	45–48	200	3.33	40	1/60	1/30	using cassette
3 mos. to 2 yrs.	A.P.	48–51	200	3.33	40	1/60	1/30	using cassette
	Lateral	48–51	200	3.33	40	1/60	1/30	using casette
2 to 5 yrs.	A.P.	51–54	200	3.33	40	1/60	1/30	using cassette
	Lateral	51–54	200	3.33	40	1/60	1/30	using cassette
5 to 7 yrs.	A.P.	50–53	200	5.	40	1/40	1/20	using cassette
	Lateral	50–53	200	5.	40	1/40	1/20	using casettes
7to12 yrs.	A.P.	53–56	200	5.	40	1/40	1/20	using cassette
	Lateral	53–56	200	5.	40	1/40	1/20	using cassette

NOTE.—*A*, Patients in plaster—add 10–15 K V. and double time.

INTRACRANIAL AIR BUBBLE STUDIES *

Suggested positions: 1. Anteroposterior standard (supine); 2. Lateral in A.P. position; 3. Lateral in P.A. position (prone); 4. Lateral view in inverted position; 5. Upright A.P.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. supine	55–60	300	7.5	40	1/40	1/20	no bucky
	Laterals	50–55	300	7.5	40	1/40	1/20	no bucky
	A.P. Upright	55–60	300	7.5	40	1/40	1/20	no bucky
3 mos. to 2 yrs.	A.P.	63–66	200	20.	40	1/10	2/10	using bucky
	Laterals	51–56	300	10.	40	1/30	1/10	no bucky
	Upright	55–60	300	10.	40	1/30	1/10	no bucky
2 to 5 yrs.	A.P.	63–66	200	30.	40	3/20	3/10	using bucky
	Laterals	56–60	200	10.	40	1/20	1/10	no bucky
	Upright	60–65	200	10.	40	1/20	1/10	no bucky
5 to 7 yrs.	A.P.	63–66	200	40.	40	2/10	4/10	using bucky
	Laterals	60–65	200	10.	40	1/20	1/10	no bucky
	Upright	65–70	200	10.	40	1/20	1/10	no bucky
7to12 yrs.	A.P.	63–68	200	50.	40	1/4	1/2	using bucky
	Laterals	62–67	200	10.	40	1/20	1/10	no bucky
	Upright	68–73	200	10.	40	1/20	1/10	no bucky

NOTE.—*A*, *See* special procedures for further explanation of procedure, positions, *etc.*

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

KNEE*

Suggested positions: 1. Anteroposterior standard; 2. Lateral standard, either flexed or extended; 3. Light lateral centered over tibial tubercle with Osgood-Schlatter's disease; 4. Tangential view of patellae to show the under surface; 5. Intercondylar or kneeling A.P. view; 6. A.P. and lateral views using Bucky Diaphragm.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	45-48	200	3.33	40	1/60	1/30	using cassette
	Lateral	45-48	200	3.33	40	1/60	1/30	using cassette
3 mos. to 2 yrs.	A.P. & Lateral	48-51	200	3.33	40	1/60	1/30	using cassette
	A.P. & Lateral	51-54	200	3.33	40	1/60	1/30	using cassette
	Light Lateral	42-45	200	3.33	40	1/60	1/30	using cassette
2 to 5 yrs.	Tang. Patellae	45-48	200	5.	40	1/40	1/20	using cassette
	Intercondylar	50-53	200	5.	40	1/40	1/20	using cassette
	A.P. & Lat.	48-50	200	10.	40	1/20	1/10	cassette & bucky
	A.P. & Lateral	50-53	200	5.	40	1/40	1/20	using cassette
	Light Lateral	42-45	200	5.	40	1/40	1/20	using cassette
5 to 7 yrs.	Tang. Patellae	50-53	200	5.	40	1/40	1/20	using cassette
	Intercondylar	50-53	200	6.67	40	1/30	1/15	using cassette
	A.P. & Lat.	50-53	200	10.	40	1/20	1/10	cassette & bucky
	A.P. & Lateral	53-56	200	5.	40	1/40	1/20	using cassette
	Light Lateral	45-48	200	5.	40	1/40	1/20	using cassette
7 to 12 yrs.	Tang. Patellae	50-53	200	6.67	40	1/30	1/15	using cassette
	Intercondylar	55-58	200	6.67	40	1/30	1/15	using cassette
	A.P. & Lat.	53-58	200	20.	40	1/10	2/10	cassette & bucky

NOTES.—*A*, Patients in plaster, add 10–15 K V. and double time.
B, Special knee positions seldom requested up to 2 yrs. of age.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

LONG BONES *

Suggested positions: 1. Anteroposterior, including wrists, elbows and lower humeri; 2. Anteroposterior, including ankles, knees and lower femora; 3. Lateral views when requested or with cases of fracture, infection, or neoplasm.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. & Lat.—Upper extremities	40-43	200	3.33	40	1/60	1/30	using cassette
	A.P. & Lat.—Lower extremities	45-48	200	3.33	40	1/60	1/30	using cassette
3 mos. to 2 yrs.	A.P. & Lat.—upper extremities	43-46	200	3.33	40	1/60	1/30	using cassette
	A.P. & Lat.—lower extremities	48-51	200	3.33	40	1/60	1/30	using cassette
2 to 5 yrs.	A.P. & Lat.—upper extremities	46-49	200	3.33	40	1/60	1/30	using cassette
	A.P. & Lat.—lower extremities	51-54	200	3.33	40	1/60	1/30	using cassette
5 to 7 yrs.	A.P. & Lat.—upper extremities	46-49	200	5.	40	1/40	1/20	using cassette
	A.P. & Lat.—lower extremities	50-53	200	5.	40	1/40	1/20	using cassette
7 to 12 yrs.	A.P. & Lat.—upper extremities	49-52	200	5.	40	1/40	1/20	using cassette
	A.P. & Lat.—lower extremities	53-56	200	5.	40	1/40	1/20	using cassette

NOTE.—*A*, Long bones in plaster; double time and add 5-15 K V. to standard positions.

* Par-speed screens. Par-speed film, 3 min. developing, 68° F.

LUMBAR SPINE *

Suggested positions: 1. Anteroposterior, either singularly or stereoscopically; 2. Lateral view; 3. 45° posterior oblique views when requested.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	63-65	200	5.	40	1/40	1/20	using grid
	Lateral	65-68	200	6.67	40	1/30	1/15	using grid
	Oblique	60-62	200	6.67	40	1/30	1/15	using grid
3 mos. to 2 yrs.	A.P.	57 60	200	10.	40	1/20	1/10	using bucky
	Lateral	65-68	200	20.	40	1/10	2/10	using bucky
	Oblique	57-60	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	A.P.	60 65	200	20.	40	1/10	2/10	using bucky
	Lateral	65-68	200	40.	40	2/10	4/10	using bucky
	Oblique	60-63	200	40.	40	2/10	4/10	using bucky
5 to 7 yrs.	A.P.	60-65	200	30.	40	3/20	3/10	using bucky
	Lateral	65 70	200	50.	40	1/4	1/2	using bucky
	Oblique	63-68	200	40.	40	2/10	4/10	using bucky
7 to 12 yrs.	A.P.	60 65	200	50.	40	1/4	1/2	using bucky
	Lateral	65 70	200	100.	40	1/2	1	using bucky
	Oblique	63-68	200	60.	40	3/10	6/10	using bucky

NOTES.—*A*, Patients in plaster jackets—double time and add 5–15 K V. depending on thickness of cast.

B, Scoliosis series, please refer to spines under scoliosis technic.

C, Patients with meningoceles—A.P. view double time and add 5–15 K V.

MALAR BONES AND ZYGOMA *

Suggested positions: 1. Posteroanterior with 3 inch cone, "Water's" position; 2. Direct lateral view of face; 3. Submental or "Hirtz" view.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A.	60-63	200	10.	Close	1/20	1/10	3 in. cone
	Lateral	50-53	200	5.	40	1/40	1/20	medium cone. No bucky
	Submental	65 70	200	20.	40	1/10	2/10	medium cone using bucky
3 mos. to 2 yrs.	P.A.	60 63	200	13.33	Close	1/15	1/8	3 in. cone
	Lateral	53-58	200	5.	40	1/40	1/20	medium cone. No bucky
	Submental	70-75	200	20.	40	1/10	2/10	medium cone using bucky
2 to 5 yrs.	P.A.	60 63	200	20.	Close	1/10	2/10	3 in. cone
	Lateral	60-65	200	20.	40	1/10	2/10	medium cone and bucky
	Submental	70-75	200	30.	40	3/20	3/10	medium cone and bucky
5 to 7 yrs.	P.A.	60 63	200	30.	Close	3/20	3/10	3 in. cone
	Lateral	60-63	200	30.	40	3/20	3/10	medium cone and bucky
	Submental	70-75	200	40.	40	2/10	4/10	medium cone and bucky
7 to 12 yrs.	P.A.	58 63	200	40.	Close	2/10	4/10	3 in. cone
	Lateral	60-63	200	40.	40	2/10	4/10	medium cone and bucky
	Submental	70 75	200	50.	40	1/4	1/2	medium cone and bucky

NOTE.—*A*, "Distance Close," allows 2 inches from end of cone to top of child's head.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

MANDIBLES *

Suggested positions: 1. Lateral oblique views; 2. Posteroanterior view with central ray directed at mandibular areas.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	Lateral-obliques	50–53	200	3.33	40	1/60	1/30	3 in. cone
	P.A.	57–60	200	3.33	40	1/60	1/30	medium cone
3 mos. to 2 yrs.	Lateral-obliques	52–55	200	3.33	40	1/60	1/30	3 in. cone
	P.A.	60–63	200	3.33	40	1/60	1/30	medium cone
2 to 5 yrs.	Lateral-obliques	50–55	200	5.	40	1/40	1/20	3 in. cone
	P.A.	60–65	200	20.	40	1/10	2/10	using bucky
5 to 7 yrs.	Lateral-obliques	55–57	200	5.	40	1/40	1/20	3 in. cone. No bucky
	P.A.	60–65	200	30.	40	3/20	3/10	using bucky
7 to 12 yrs.	Lateral-obliques	55–60	200	6.67	40	1/30	1/15	cassette. No bucky
	P.A.	60–65	200	40.	40	2/10	4/10	using bucky

NOTE.—*A*, Occlusal dental films are of diagnostic value for anterior mandibular area, use 3 inch cone, distance 20 inch; K V. 60–65; time 3/10–5/10; projection, occlusal plane.

MASTOIDS *

Suggested positions: 1. Laterals, either singularly or stereoscopically with cassette, tilted 15° and tube perpendicular; 2. Anteroposterior view of basilar skull, mastoids, and petrous tips for bilateral comparison.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	Lateral	53–55	200	5.	Close	1/40	1/20	cassette
	Basilar A.P.	63–65	200	5.	40	1/40	1/20	cassette—no bucky
3 mos. to 2 yrs.	Lateral	55–58	200	5.	Close	1/40	1/20	cassette
	Basilar A.P.	65–70	200	20.	40	1/10	2/10	cassette and bucky
2 to 5 yrs.	Lateral	57–60	200	6.67	Close	1/30	1/15	cassette
	Basilar A.P.	67–72	200	30.	40	3/20	3/10	cassette and bucky
5 to 7 yrs.	Lateral	60–62	200	6.67	Close	1/30	1/15	cassette
	Basilar A.P.	67–72	200	40.	40	2/10	4/10	cassette and bucky
7 to 12 yrs.	Lateral	60–65	200	10.	Close	1/20	1/10	cassette
	Basilar A.P.	67–72	200	50.	40	1/4	1/2	cassette and bucky

NOTE.—*A*, "Distance Close" allows 2 inches from cone to child's head.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

MAXILLAE *

Suggested positions: 1. Posteroanterior, using "Water's" sinus position; 2. Lateral spot film centered over maxillary area.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A.	60-63	200	10.	Close	1/20	1/10	using 3 in. cone
	Lateral	60-63	200	5.	20	1/40	1/20	using 3 in. cone
3 mos. to 2 yrs.	P.A.	60-65	200	13.33	Close	1/15	1/8	using 3 in. cone
	Lateral	57-62	200	6.67	20	1/30	1/15	using 3 in. cone
2 to 5 yrs.	P.A.	60-65	200	20.	Close	1/10	2/10	using 3 in. cone
	Lateral	57-62	200	10.	20	1/20	1/10	using 3 in. cone
5 to 7 yrs.	P.A.	60-65	200	30.	Close	3/20	3/10	using 3 in. cone
	Lateral	57-62	200	20.	20	1/10	2/10	3 in. cone using bucky
7 to 12 yrs.	P.A.	60-65	200	40.	Close	2/10	4/10	using 3 in. cone
	Lateral	57-62	200	30.	20	3/20	3/10	3 in. cone using bucky

NOTES.—*A*, Occlusal dental films are of diagnostic value for anterior maxillae; use 3 inch cone, distance 20 in., K V. 65–70; time 3/10–1/2 sec. depending on thickness of maxillary bone. Projection—occlusal plane.

B, "Distance Close" allows 2 inches from cone to child's head.

NASAL BONES *

Suggested positions: 1. P.A. using "Water's" position; 2. Laterals of each side, using exposure holder.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A.	60-63	200	10.	Close	1/20	1/10	using cassette
	Laterals	63-65	200	13.33	40	1/15	1/8	exposure holder
3 mos. to 2 yrs.	P.A.	60-63	200	13.33	Close	1/15	1/8	cassette & 3 in. cone
	Laterals	63-65	200	20.	40	1/10	2/10	exposure holder & 3 in. cone
2 to 5 yrs.	P.A.	60-63	200	20.	Close	1/10	2/10	cassette & 3 in. cone
	Laterals	65-70	200	20.	40	1/10	2/10	exposure holder & 3 in. cone
5 to 7 yrs.	P.A.	60-63	200	30.	Close	3/20	3/10	cassette & 3 in. cone
	Laterals	65-70	200	30.	40	3/20	3/10	exposure holder & 3 in. cone
7 to 12 yrs.	P.A.	58-63	200	40.	Close	2/10	4/10	cassette & 3 in. cone
	Laterals	65-70	200	50.	40	1/4	1/2	exposure holder & 3 in. cone

NOTES.—*A*, Sinuses, please refer to same under special heading.

B, "Distance Close" allows 2 inches from cone to child's head.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

NECK (SOFT TISSUE VISUALIZATION)*

Suggested positions: 1. Anteroposterior, with chin elevated and tube tilted 10° cephalad; 2. Lateral to show pharynx, larynx, and proximal trachea.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	47–50	200	3.33	40	1/60	1/30	using medium cone
	Lateral	47–50	200	3.33	40	1/60	1/30	using medium cone—4–6 inch
3 mos. to 2 yrs.	A.P.	50–53	200	3.33	40	1/60	1/30	using medium cone
	Lateral	50–53	200	3.33	40	1/60	1/30	using medium cone—4–6 inch
2 to 5 yrs.	A.P.	53–55	200	3.33	40	1/60	1/30	using medium cone
	Lateral	53–55	200	3.33	40	1/60	1/30	using medium cone—4–6 inch
5 to 7 yrs.	A.P.	50–53	200	5.	40	1/40	1/20	using medium cone
	Lateral	50–53	200	5.	40	1/40	1/20	using medium cone—4–6 inch
7 to 12 yrs.	A.P.	53–57	200	5.	40	1/40	1/20	using medium cone
	Lateral	53–57	200	5.	40	1/40	1/20	using medium cone—4–6 inch

NOTE.—*A*, For bone delineation, please refer to cervical spine.

ORBITS AND OPTIC FORAMINA*

Suggested positions: 1. For orbits, posteroanterior view, using 3 inch cone, with cassette tilted 15°, and central ray perpendicular (frontal sinus position); 2. Optic foramina; P.A. oblique, with 3 inch cone, cassette flat, and outer canthus of the eye, malar bone, and tip of the nose in contact with film. Tube in perpendicular position.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A.	60–63	200	10.	Close	1/20	1/10	3 inch cone
	Oblique	60–63	200	6.67	Close	1/30	1/15	3 inch cone
3 mos. to 2 yrs.	P.A.	60–63	200	13.33	Close	1/15	1/8	3 inch cone
	Oblique	60–63	200	10.	Close	1/20	1/10	3 inch cone
2 to 5 yrs.	P.A.	60–63	200	20.	Close	1/10	2/10	3 inch cone
	Oblique	60–63	200	13.33	Close	1/15	1/8	3 inch cone
5 to 7 yrs.	P.A.	60–63	200	30.	Close	3/20	3/10	3 inch cone. No bucky
	Oblique	60–63	200	20.	Close	1/10	2/10	3 inch cone. No bucky
7 to 12 yrs.	P.A.	60–65	200	40.	Close	2/10	4/10	3 inch cone. No bucky
	Oblique	60–65	200	30.	Close	3/20	3/10	3 inch cone. No bucky

NOTE.—*A*, "Distance Close" allows 2 inches from cone to child's head.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

RHINOGRAMS *

Suggested positions: 1. Lateral view of face, using 4–6 inch cone, patient supine with tube horizontal and cassette perpendicular; 2. Anteroposterior view centered over nose. Both views taken in rapid sequence following Lipiodol instillation.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	Lateral	58-61	200	3.33	40	1/60	1/30	using cassette
	A.P.	65-68	200	5.	40	1/40	1/20	using cassette
3 mos. to 2 yrs.	Lateral	58-61	200	5.	40	1/40	1/20	using cassette
	A.P.	65-68	200	6.67	40	1/30	1/15	using cassette
2 to 5 yrs.	Lateral	61-64	200	5.	40	1/40	1/20	using cassette
	A.P.	68-70	200	6.67	40	1/30	1/15	using cassette
5 to 7 yrs.	Lateral	58-61	200	6.67	40	1/30	1/15	using cassette
	A.P.	65-67	200	30.	40	3/20	3/10	cassette. Using bucky
7 to 12 yrs.	Lateral	55-60	200	6.67	40	1/30	1/15	using cassette
	A.P.	65-68	200	40.	40	2/10	4/10	cassette. Using bucky

NOTE.—*A*, For explanation of Rhinograms—*see* under Special Procedures.

RIBS *

Suggested positions: 1. Either anteroposterior or posteroanterior, as area warrants; 2. Oblique view either anterior or posterior, when area of interest is axillary, or on curve of ribs.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. or P.A.	50-53	200	3.33	40	1/60	1/30	no bucky
	Oblique	60-62	200	3.33	40	1/60	1/30	no bucky
3 mos. to 2 yrs.	A.P. or P.A.	53-58	200	3.33	40	1/60	1/30	no bucky
	Oblique	62-65	200	3.33	40	1/60	1/30	no bucky
2 to 5 yrs.	A.P. or P.A.	58-61	200	10.	40	1/20	1/10	using bucky
	Oblique	61-64	200	10.	40	1/20	1/10	using bucky
5 to 7 yrs.	A.P. or P.A.	60-62	200	20.	40	1/10	2/10	using bucky
	Oblique	62-64	200	20.	40	1/10	2/10	using bucky
7 to 12 yrs.	A.P. or P.A.	62-65	200	20.	40	1/10	2/10	using bucky
	Oblique	63-67	200	30.	40	3/20	3/10	using bucky

NOTES.—*A*, Chest for lung detail, *see* under Chest.
B, Patients in plaster jackets—double time and add 5–15 K V.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

SACRUM AND COCCYX *

Suggested positions: 1. Anteroposterior, either singularly or stereoscopically; 2. Anteroposterior with 15° tilt of tube cephalad, for visualization of sacroiliac joints; 3. Lateral view; 4. Spot 45° posterior oblique views when requested.

Coccyx.—1. Anteroposterior spot film; 2. Lateral spot film.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	63-65	200	5.	40	1/40	1/20	using grid
	Lateral	65-67	200	6.67	40	1/30	1/15	using grid
	Oblique	60-62	200	6.67	40	1/30	1/15	using grid
3 mos. to 2 yrs.	A.P.	57-60	200	10.	40	1/20	1/10	using bucky
	Lateral	65-68	200	20.	40	1/10	2/10	using bucky
	Oblique	57-60	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	A.P.	60-65	200	20.	40	1/10	2/10	using bucky
	A.P. with 15° cephalic tilt	70-75	200	20.	40	1/10	2/10	using bucky
	Lateral	65-68	200	40.	40	2/10	4/10	using bucky
	Oblique.	60-63	200	40.	40	2/10	4/10	using bucky
5 to 7 yrs.	A.P.	60-65	200	30.	40	3/20	3/10	using bucky
	A.P. with 15° cephalic tilt	70-75	200	30.	40	3/20	3/10	using bucky
	Lateral	65-70	200	50.	40	1/4	1/2	using bucky
	Oblique	63-68	200	40.	40	2/10	4/10	using bucky
7 to 12 yrs.	A.P.	60-65	200	50.	40	1/4	1/2	using bucky
	A.P. with 15° cephalic tilt	70-75	200	50.	40	1/4	1/2	using bucky
	Lateral	65-70	200	100.	40	1/2	1	using bucky
	Oblique	63-68	200	60.	40	3/10	6/10	using bucky

NOTES.—*A*, Patients in plaster jackets—double time and add 5–15 K V., depending on thickness of cast.

B, Patients with sacral meningoceles, double time and add 5–15 K V.

SCAPULAE*

Suggested positions: 1. Anteroposterior of one or both scapulae with patient supine, arms at sides and arms supine; 2. Direct lateral of scapula with patient in posteroanterior, oblique position.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P.	50-53	200	3.33	40	1/60	1/30	no grid
	Lateral	55-58	200	5.	40	1/40	1/20	using 3 in. cone
3 mos. to 2 yrs.	A.P.	53-56	200	3.33	40	1/60	1/30	no grid
	Lateral	58-62	200	5.	40	1/40	1/20	using 3 in. cone
2 to 5 yrs.	A.P.	52-55	200	5.	40	1/40	1/20	no grid
	Lateral	58-62	200	6.67	40	1/30	1/15	using 3 in. cone
5 to 7 yrs.	A.P.	58-62	200	20.	40	1/10	2/10	using bucky
	Lateral	60-63	200	40.	40	2/10	4/10	using bucky
7 to 12 yrs.	A.P.	58-62	200	30.	40	3/20	3/10	using bucky
	Lateral	63-67	200	40.	40	2/10	4/10	using bucky

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

SHOULDERS *

Suggested positions: 1. Anteroposterior view of both shoulders with patient supine, arms adducted and supinated; 2. Lateral view of both shoulders and proximal humeri with patient supine, arms abducted and arms externally rotated; 3. A true lateral of shoulder joint with central ray projected through the axilla; 4. Stereoscopic A.P. view of either shoulder.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. & Lat.	48-50	200	3.33	40	1/60	1/30	no grid
	Lat. view through axilla	55-60	200	5.	40	1/40	1/20	using 3 in. cone
3 mos. to 2 yrs.	A.P. & Lat.	50-53	200	3.33	40	1/60	1/30	no grid or bucky
	Lat. view through axilla	60-65	200	5.	40	1/40	1/20	using 3 in. cone
2 to 5 yrs.	A.P. & Lat.	50-53	200	5.	40	1/40	1/20	no grid or bucky
	Lat. view through axilla	60-65	200	6.67	40	1/30	1/15	using 3 in. cone
	A.P.	50-53	200	20.	40	1/10	2/10	using bucky
5 to 7 yrs.	A.P. & Lat.	53-55	200	5.	40	1/40	1/20	no bucky or grid
	Lat. view through axilla	63-65	200	6.67	40	1/30	1/15	using 3 in. cone
	A.P.	53-55	200	20.	40	1/10	2/10	using bucky
7 to 12 yrs.	A.P. & Lat.	50-55	200	6.67	40	1/30	1/15	no grid or bucky
	Lat. view through axilla	62-67	200	10.	40	1/20	1/10	using 3 in. cone
	A.P. view	55-60	200	20.	40	1/10	2/10	using bucky

NOTES.—*A*, Technic for scapulae—*see* under Scapulae.

B, Patients in plaster—double time and add 10–15 K V. depending on thickness of cast.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

SINUSES *

Suggested positions: 1. Posteroanterior view (Water's position) with chin and tip of nose touching cassette, with cassette tilted 15° and tube perpendicular; 2. Frontal position, with forehead and nose in contact, tube and cassette as described previously; 3. Lateral view with patient supine, tube horizontal and cassette perpendicular. Expose at passive expiration with cooperative patients and at inspiration with little children. Mouth must be closed or held firmly, with webbing strap, beneath patient's chin.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	"Water's" view	60-63	200	10.	Close	1/20	1/10	3 in. cone
	Frontal view	58-61	200	10.	Close	1/20	1/10	3 in. cone
	Lateral view	58-61	200	3.33	40	1/60	1/30	medium cone—4-6 inch
3 mos. to 2 yrs.	"Water's" view	60-63	200	13.33	Close	1/15	1/8	3 in. cone
	Frontal view	58-61	200	13.33	Close	1/15	1/8	3 in. cone
	Lateral view	58-61	200	5.	40	1/40	1/20	medium cone—4-6 inch
2 to 5 yrs.	"Water's" view	60-63	200	20.	Close	1/10	2/10	3 in. cone
	Frontal view	58-61	200	20.	Close	1/10	2/10	3 in. cone
	Lateral view	61-64	200	5.	40	1/40	1/20	medium cone—4-6 inch
5 to 7 yrs.	"Water's" view	60-63	200	30.	Close	3/20	3/10	3 in. cone
	Frontal view	58-61	200	30.	Close	3/20	3/10	3 in. cone
	Lateral	58-61	200	6.67	40	1/30	1/15	medium cone—4-6 inch
7 to 12 yrs.	"Water's"	58-63	200	40.	Close	2/10	4/10	3 in. cone
	Frontal view	55-60	200	40.	Close	2/10	4/10	3 in. cone
	Lateral view	55-60	200	6.67	40	1/30	1/15	medium cone—4-6 inch

NOTES.—*A*, Upright sinus films with Lipiodol instillation warrant an average increase of 5–10 K V.

B, "Distance Close" allows 2 inches from cone to child's head.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

SKULL *

Suggested positions: 1. Anteroposterior; 2. Posteroanterior; 3. Basilar or Occipital position; 4. Submental or Hirtz view; 5. Tangential; 6. Laterals of both sides including one stereoscopic set.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
	A.P. & P.A.	56-58	300	5.	40	1/60	1/20	no bucky
Birth to 3	Basilar view	58-60	300	5.	40	1/60	1/20	no bucky
mos.	Hirtz view	65-70	200	20.	40	1/10	2/10	using bucky
	Tangential	44-46	300	5.	40	1/60	1/20	no bucky
	Laterals	48-50	300	5.	40	1/60	1/20	no bucky
	A.P. & P.A.	65-70	200	20.	40	1/10	2/10	using bucky
3 mos. to	Basilar view	67-72	200	20.	40	1/10	2/10	using bucky
2 yrs.	Hirtz view	70-75	200	20.	40	1/10	2/10	using bucky
	Tangential	55-57	200	20.	40	1/10	2/10	using bucky
	Laterals	58-63	200	20.	40	1/10	2/10	using bucky
	A.P. & P.A.	63-66	200	30.	40	3/20	3/10	using bucky
	Basilar view	67-72	200	30.	40	3/20	3/10	using bucky
2 to 5 yrs.	Hirtz view	70-75	200	30.	40	3/20	3/10	using bucky
	Tangential	55-57	200	30.	40	3/20	3/10	using bucky
	Laterals	56-60	200	30.	40	3/20	3/10	using bucky
	A.P. & P.A.	63-66	200	40.	40	2/10	4/10	using bucky
	Basilar view	67-72	200	40.	40	2/10	4/10	using bucky
5 to 7 yrs.	Hirtz view	70-75	200	40.	40	2/10	4/10	using bucky
	Tangential	55-57	200	40.	40	2/10	4/10	using bucky
	Laterals	56-60	200	40.	40	2/10	4/10	using bucky
	A.P. & P.A.	63-68	200	50.	40	1/4	1/2	using bucky
	Basilar view	67-72	200	50.	40	1/4	1/2	using bucky
7 to 12 yrs.	Hirtz view	70-75	200	50.	40	1/4	1/2	using bucky
	Tangential	55-60	200	50.	40	1/4	1/2	using bucky
	Laterals	56-60	200	50.	40	1/4	1/2	using bucky

NOTE.—*A*, Encephalograms and ventriculograms, and air bubble studies refer to each under headings.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

SPINE FOR SCOLIOSIS *

Suggested positions: 1. Anteroposterior recumbent using large cassette; 2. Anteroposterior left and right lateral bending positions with pelvis fixed and patient in maximum bend, but not rotated. These views also recumbent, and barely including iliac crests; 3. Direct lateral of spine, just including iliac crests; 4. A.P. upright, sitting including iliac crests, large cassette; 5. A.P. upright sitting, with large sandbag under one buttock. Patient not allowed to grasp table, but endeavoring to maintain balance; 6. A.P. upright standing, including iliac crests, large cassette. Remove shoes; 7. A.P. upright, standing, including iliac crests with any desired lift under either foot. This latter position valuable with patients with a short extremity.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
	A.P. recumbent	63–65	200	5.	40	1/40	1/20	using grid
Birth to 3	A.P. upright	65–68	200	5.	40	1/40	1/20	using grid
mos.	A.P. sitting	65–68	200	5.	40	1/40	1/20	using grid
	Lateral	65–68	200	6.67	40	1/30	1/15	using grid
	A.P. recumbent	63–67	200	10.	40	1/20	1/10	using bucky
3 mos. to	A.P. upright	68–72	200	10.	40	1/20	1/10	using bucky
2 yrs.	A.P. sitting	68–72	200	10.	40	1/20	1/10	using bucky
	Lateral	65–69	200	20.	40	1/10	2/10	using bucky
	A.P. recumbent	62–67	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	A.P. upright	67–72	200	20.	40	1/10	2/10	using bucky
	A.P. sitting	67–72	200	20.	40	1/10	2/10	using bucky
	Lateral	63–67	200	40.	40	2/10	4/10	using bucky
	A.P. recumbent	62–67	200	30.	40	3/20	3/10	using bucky
5 to 7 yrs.	A.P. upright	67–72	200	30.	40	3/20	3/10	using bucky
	A.P. sitting	67–72	200	30.	40	3/20	3/10	using bucky
	Lateral	63–68	200	60.	40	3/10	6/10	using bucky
	A.P. recumbent	62–67	200	50.	40	1/4	1/2	using bucky
7 to 12 yrs.	A.P. upright	65–70	200	50.	40	1/4	1/2	using bucky
	A.P. sitting	65–70	200	50.	40	1/4	1/2	using bucky
	Lateral	70–75	200	100.	40	1/2	1	using bucky

NOTES.—*A*, Patients in plaster jackets—double time and add 5–15 K V., depending on thickness of casts.

B, Patients with meningoceles—A.P. views double time and add 5–15 K V.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

STERNUM *

Suggested positions: 1. A direct lateral with patient supine, arms held on either side of head. Tube horizontal and cassette perpendicular; 2. Posteroanterior view with patient in good contact, but tube tilted 15°–20° to throw spine to either side and allow unobstructed view of sternum; 3. Posteroanterior oblique views of either or both sides.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	Lateral view	55-60	400	6.67	40	1/60	1/15	supine at inspiration
	P.A. view	43-48	400	6.67	40	1/60	1/15	prone at inspiration
	Oblique view	47-52	400	6.67	40	1/60	1/15	prone at inspiration
3 mos. to 2 yrs.	Lateral view	60-65	400	6.67	40	1/60	1/15	supine at inspiration
	P.A. view	47-52	400	6.67	40	1/60	1/15	prone at inspiration
	Oblique view	52-57	400	6.67	40	1/60	1/15	prone at inspiration
2 to 5 yrs.	Lateral view	62-67	400	10.	40	1/40	1/10	supine at inspiration
	P.A. view	52-57	400	10.	40	1/40	1/10	prone at inspiration
	Oblique view	57-62	400	10.	40	1/40	1/10	prone at inspiration
5 to 7 yrs.	Lateral view	62-67	400	10.	40	1/40	1/20	supine. Using bucky
	P.A. view	60 65	200	20.	40	1/10	2/10	prone at inspiration
	Oblique view	60-65	200	20.	40	1/10	2/10	prone at inspiration
7 to 12 yrs.	Lateral view	65-70	400	13.33	40	1/30	1/8	supine. Using bucky
	P.A. view	65-70	200	30.	40	3/20	3/10	prone at inspiration
	Oblique view	65-70	200	30.	40	3/20	3/10	prone at inspiration

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

TELEROENTGENOGRAMS*

Suggested positions: 1. Anteroposterior view from knee to ankle including both joints; 2. Anteroposterior view from hip to knee including both joints; 3. Anteroposterior view of both forearms including wrist and elbow joint; 4. Anteroposterior view of both humeri including elbow and shoulder joints.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
	A.P. forearms	50–52	200	5.	72	1/40	1/20	using cassette
Birth to 3	A.P. humeri	52–55	200	5.	72	1/40	1/20	using cassette
mos.	A.P. tibiae	52–55	200	5.	72	1/40	1/20	using cassette
	A.P. femora	55–58	200	5.	72	1/40	1/20	using cassette
	A.P. forearms	52–55	200	5.	72	1/40	1/20	using cassette
3 mos. to	A.P. humeri	55–58	200	5.	72	1/40	1/20	using cassette
	A.P. tibiae	55–58	200	5.	72	1/40	1/20	using cassette
2 yrs.	A.P. femora	55–60	200	6.67	72	1/30	1/15	using cassette
	A.P. forearms	52–55	200	6.67	72	1/30	1/15	using cassette
2 to 5 yrs.	A.P. humeri	55–58	200	6.67	72	1/30	1/15	using cassette
	A.P. tibiae	55–58	200	6.67	72	1/30	1/15	using cassette
	A.P. femora	55–60	200	10.	72	1/20	1/10	using cassette
	A.P. forearms	55–60	200	6.67	72	1/30	1/15	using cassette
5 to 7 yrs.	A.P. humeri	55–60	200	10.	72	1/20	1/10	using cassette
	A.P. tibiae	60–65	200	10.	72	1/20	1/10	using cassette
	A.P. femora	60–65	200	20.	72	1/10	2/10	using cassette
	A.P. forearms	60–65	200	6.67	72	1/30	1/15	using cassette
7to12yrs.	A.P. humeri	60–65	200	10.	72	1/20	1/10	using cassette
	A.P. tibiae	60–65	200	20.	72	1/10	2/10	using cassette
	A.P. femora	60–65	200	40.	72	2/10	4/10	using cassette

NOTE.—*A*, Lower extremities with the older groups are often too long to be measured with teleroentgenograms. These need special apparatus for accurate measurements.

TEMPOROMANDIBULAR JOINT*

Suggested positions: 1. Spot laterals with cassette tilted 15° and tube perpendicular; (one) with mouth open, (two) with mouth closed. C.R. directed at centered area; 2. Anteroposterior view of skull with Bucky Diaphragm, with central ray projected at temporomandibular joints.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3	Laterals	53–55	200	5.	Close	1/40	1/20	using 3 in. cone
mos.	A.P.	65–67	200	5.	40	1/40	1/20	using medium cone
3 mos. to	Laterals	55–58	200	5.	Close	1/40	1/20	using 3 in. cone
2 yrs.	A.P.	63–68	200	20.	40	1/10	2/10	using bucky
2 to 5 yrs.	Laterals	57–60	200	6.67	Close	1/30	1/15	using 3 in. cone
	A.P.	65–70	200	30.	40	3/20	3/10	using bucky
5 to 7 yrs.	Laterals	60–62	200	6.67	Close	1/30	1/15	using 3 in. cone
	A.P.	65–70	200	40.	40	2/10	4/10	using bucky
7 to 12 yrs.	Laterals	60–65	200	10.	Close	1/20	1/10	using 3 in. cone
	A.P.	65–70	200	50.	40	1/4	1/2	using bucky

NOTES.—*A*, Distal mandible positions—please refer to mandible under technic.
B, "Position Close" allows 2 inches from cone to child's head.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

URETHROGRAM *

Suggested positions: 1. Right or left posterior oblique positions with under leg flexed to maximum degree and other leg extended. Suggest use of grid up to 5 years for better soft tissue visualization; 2. Anteroposterior view with grid and medium cone if requested.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	Oblique	65–68	200	6.67	40	1/30	1/15	using grid
	A.P. view	63–66	200	6.67	40	1/30	1/15	using grid
3 mos. to 2 yrs.	Oblique	67–70	200	10.	40	1/20	1/10	using grid
	A.P. view	65–68	200	10.	40	1/20	1/10	using grid
2 to 5 yrs.	Oblique	70–73	200	10.	40	1/20	1/10	using grid
	A.P. view	68–71	200	10.	40	1/20	1/10	using grid
5 to 7 yrs.	Oblique	63–66	200	20.	40	1/10	2/10	using bucky
	A.P. view	60–63	200	20.	40	1/10	2/10	using bucky
7 to 12 yrs.	Oblique	63–68	200	40.	40	2/10	4/10	using bucky
	A.P. view	60–65	200	40.	40	2/10	4/10	using bucky

NOTES.—*A*, *See* under Special Procedures for explanation.
B, Cystogram under own heading.

I. V. UROGRAMS AND RETROGRADE PYELOGRAMS *

Suggested positions: 1. Anteroposterior views including kidneys, ureters, and bladder @ 5 min.–15 min. and 30 minutes post-intravenous injection, plus any additional later A.P. views needed; 2. Lateral view; 3. Upright anteroposterior view; 4. Either posterior oblique whenever needed.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	A.P. Supine	63–65	200	5.	40	1/40	1/20	using grid
	A.P. Upright	67–70	200	5.	40	1/40	1/20	using grid
	Oblique	67–70	200	5.	40	1/40	1/20	using grid
	Lateral	67–70	200	6.67	40	1/30	1/15	using grid
3 mos. to 2 yrs.	A.P. Supine	65–68	200	6.67	40	1/30	1/15	using grid
	A.P. Upright	67–70	200	6.67	40	1/30	1/15	using grid
	Oblique	67–70	200	6.67	40	1/30	1/15	using grid
	Lateral	67–70	200	10.	40	1/20	1/10	using grid
2 to 5 yrs.	A.P. Supine	67–70	200	10.	40	1/20	1/10	using bucky
	A.P. Upright	70–73	200	10.	40	1/20	1/10	using bucky
	Oblique	70–73	200	10.	40	1/20	1/10	using bucky
	Lateral	70–73	200	20.	40	1/10	2/10	using bucky
5 to 7 yrs.	A.P. Supine	60–63	200	20.	40	1/10	2/10	using bucky
	A.P. Upright	65–68	200	20.	40	1/10	2/10	using bucky
	Oblique	67–70	200	20.	40	1/10	2/10	using bucky
	Lateral	67–70	200	40.	40	2/10	4/10	using bucky
7 to 12 yrs.	A.P. Supine	60–65	200	30.	40	3/20	3/10	using bucky
	A.P. Upright	67–72	200	30.	40	3/20	3/10	using bucky
	Oblique	67–72	200	30.	40	3/20	3/10	using bucky
	Lateral	67–72	200	60.	40	3/10	6/10	using bucky

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

WRISTS AND HANDS *

Suggested positions: 1. Posteroanterior of both hands and wrists for "Bone Age" requests using exposure holder; 2. A.P., lateral, and posteroanterior oblique views in questionable injuries of distal radii, ulnae, carpal bones, metacarpals, and phalanges.

Age group	*Position*	*K V.*	*M A.*	*M A S.*	*Dist. inches*	*Preferred time in sec.*	*Alternate time in sec. at 100 M A.*	*Remarks*
Birth to 3 mos.	P.A. both wrists	63-65	200	10.	40	1/20	1/10	using exposure holder
	A.P. Lat. & oblique	37-40	200	3.33	40	1/60	1/30	using cassette
	All views—casts	52-55	200	5.	40	1/40	1/20	using cassette
3 mos. to 2 yrs.	P.A. both wrists	63-65	200	13.33	40	1/15	1/8	using exposure holder
	A.P. Lat. & oblique	40 43	200	3.33	40	1/60	1/30	using cassette
	All views—casts	55 58	200	5.	40	1/40	1/20	using cassette
2 to 5 yrs.	P.A. both wrists	63-68	200	20.	40	1/10	2/10	using exposure holder
	A.P. Lat. & oblique	43-45	200	3.33	40	1/60	1/30	using cassette
	All views—casts	58-61	200	5.	40	1/40	1/20	using cassette
5 to 7 yrs.	A.P. both wrists	63-67	200	40.	40	2/10	4/10	using exposure holder
	A.P. Lat. & oblique	45-47	200	3.33	40	1/60	1/30	using cassette
	All views—casts	58-61	200	6.67	40	1/30	1/15	using cassette
7 to 12 yrs.	A.P. both wrists	67-70	200	50.	40	1/4	1/2	using exposure holder
	A.P. Lat. & oblique	45-50	200	5.	40	1/40	1/20	using cassette
	All views—casts	61-65	200	6.67	40	1/30	1/15	using cassette

NOTE.—*A*, Consideration should be given to the thickness of the casts, rather than age groups. Above technic applicable to medium cast thicknesses.

B, Cooperative children usually will straighten out their fingers and may be taken in the standard A.P. position.

* Par-speed screens, Par-speed film, 3 min. developing, 68° F.

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